

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

BASF CORPORATION,
Petitioner,

v.

INGEVITY SOUTH CAROLINA, LLC,
Patent Owner.

PGR2020-00037
Patent 10,323,553 B2

Before CHRISTOPHER L. CRUMBLEY, CHRISTOPHER M. KAISER,
and JULIA HEANEY, *Administrative Patent Judges*.

HEANEY, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining No Challenged Claims Unpatentable
Dismissing Motions to Exclude as Moot
35 U.S.C. § 328(a)

I. INTRODUCTION

BASF Corporation (“Petitioner”) filed a Petition to institute a post-grant review of claims 1–10, 14–28, 32–38, 51, 52, 55–57, 59, 64–72, and 76–82 of U.S. Patent No. 10,323,553 B2 (Ex. 1001, “the ’553 patent”). Paper 3 (“Petition” or “Pet.”). Ingevity South Carolina, LLC (“Patent Owner”) filed a Preliminary Response. Paper 7. In our Institution Decision (Paper 19, “Dec. on Inst.”), we determined Petitioner had shown it was more likely than not to prevail with respect to its challenge to claims 1 and 21 of the ’553 patent based on obviousness. Dec. on Inst. 37. Accordingly, we instituted trial as to all claims challenged in the petition and on all grounds in the petition. Consolidated Trial Practice Guide 5 (Nov. 2019) (“Trial Practice Guide”), <http://www.uspto.gov/TrialPracticeGuideConsolidated> (“In instituting a trial, the Board will either (1) institute as to all claims challenged in the petition and on all grounds in the petition, or (2) institute on no claims and deny institution.”).

During the course of trial, Patent Owner filed a Patent Owner Response (Paper 44, “PO Resp.”); Petitioner filed a Reply to the Patent Owner Response (Paper 52, “Pet. Reply”); Patent Owner filed a Sur-reply (Paper 61, “PO Sur-reply”). The parties also filed motions to exclude evidence (Papers 56 and 57), which we address *infra*. An oral hearing was held on June 11, 2021, and a transcript of the hearing is included in the record. Paper 71 (“Tr.”).

A. *Related Proceedings*

The parties identify PGR2020-00035 as a related proceeding involving the ’553 patent. Pet. 101; Paper 5, 2. In that case, we denied

institution of trial. PGR2020-00035, Paper 11. The parties state they are not aware of any other judicial or administrative proceeding involving the '553 patent. *Id.*

B. The '553 Patent

The '553 patent, titled “Evaporative Fuel Vapor Emission Control Systems,” describes canister systems that employ activated carbon to adsorb fuel vapor emitted from motor vehicle fuel systems and reduce hydrocarbon air pollution. Ex. 1001, code (54), 1:29–33. The adsorbed fuel vapor can be “periodically removed from the activated carbon by purging the canister systems with ambient air [while the engine is turned on] to desorb the fuel vapor from the activated carbon,” after which the “regenerated carbon is then ready to adsorb additional fuel vapor.” *Id.* at 1:33–38; 53–58.

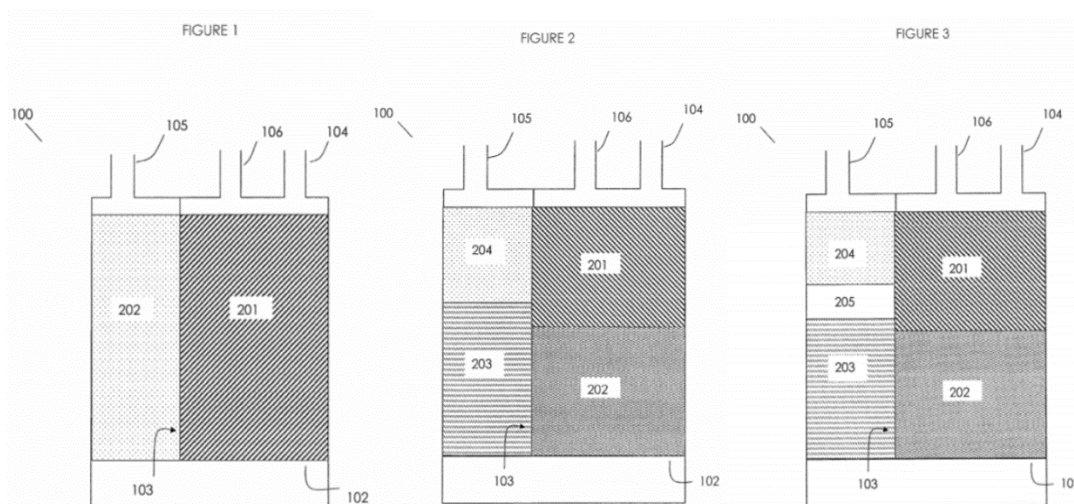
According to the '553 patent, however, “[t]he purge air does not desorb the entire fuel vapor adsorbed on the adsorbent volume, resulting in a residue hydrocarbon (‘heel’) that may be emitted to the atmosphere.” *Id.* at 1:58–61.

The '553 patent states “[a]n increase in environmental concerns has continued to drive strict regulations of the hydrocarbon emissions from motor vehicles even when the vehicles are not operating.” *Id.* at 1:39–41. “When a vehicle is parked in a warm environment during the daytime heating (i.e., diurnal heating), the temperature in the fuel tank increases resulting in an increased vapor pressure in the fuel tank.” *Id.* at 1:42–45. The '553 patent explains that the “heel in local equilibrium with the gas phase also permits fuel vapors from the fuel tank to migrate through the canister system as emissions,” and “[s]uch emissions typically occur when a vehicle has been parked and subjected to diurnal temperature changes over a period of several days, commonly called ‘diurnal breathing losses’

["DBL"].” *Id.* at 1:61–67. The ’553 patent further states that the “California Low Emission Vehicle Regulation (LEV-III) requires canister DBL emissions not to exceed 20 mg.” *Id.* at 2:6–8.

The ’553 patent explains that DBL emissions may be “more severe for a hybrid vehicle that includes both an internal combustion engine and an electric motor,” because, in such vehicles, “the internal combustion engine is turned off nearly half of the time during vehicle operation.” *Id.* at 2:46–51. “Since the adsorbed fuel vapor on the adsorbents is purged only when the internal combustion engine is on, the adsorbents in the canister of a hybrid vehicle is purged with fresh air less than half of the time compared to conventional vehicles.” *Id.* at 2:51–55. Yet, “[a] hybrid vehicle generates nearly the same amount of evaporative fuel vapor as the conventional vehicles.” *Id.* at 55–57. The ’553 patent explains “[t]he lower purge frequency of the hybrid vehicle can be insufficient to clean the residue hydrocarbon heel from the adsorbents in the canister, resulting in high diurnal breathing loss (DBL) emissions.” *Id.* at 57–60. Therefore, according to the ’553 patent, “it is desirable to have an evaporative emission control system with low diurnal breathing loss (DBL) emissions even when a low level of purge air is used, or when the adsorbents in the canister are purged less frequently such as in the case of hybrid vehicles, or both.” *Id.* at 2:61–65.

The ’553 patent describes several example embodiments of evaporative emission control canister systems to address the above problems. *Id.* at 4:10–20. Figures 1–3 of the ’553 patent, reproduced below, depict a first group of canister system embodiments.



Figures 1–3 are evaporative emission control canister systems having “an initial adsorbent volume and subsequent adsorbent volume(s) ... located within a single canister.” *Id.* at 4:10–14. An “adsorbent volume” refers to “an adsorbent material or adsorbent containing material along vapor flow path, and may consist of a bed of particulate material, a monolith, honeycomb, sheet or other material.” *Id.* at 6:32–36. Figure 1 illustrates “[c]anister system 100 includ[ing] a support screen 102, a dividing wall 103, a fuel vapor inlet 104 from a fuel tank, a vent port 105 opening to an atmosphere, a purge outlet 106 to an engine, an initial adsorbent volume 201, and a subsequent adsorbent volume 202.” *Id.* at 4:24–28. The ’553 patent explains the operation of canister system 100 as follows:

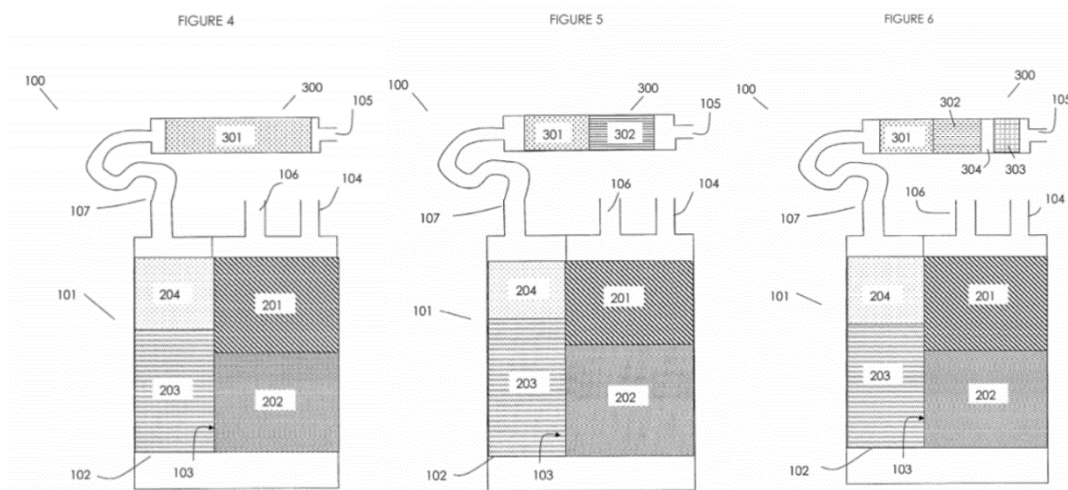
When an engine is off, the fuel vapor from a fuel tank enters the canister system 100 through the fuel vapor inlet 104. The fuel vapor diffuses into the initial adsorbent volume 201, and then the subsequent adsorbent volume 202 before being released to the atmosphere through the vent port 105 of the canister system. Once the engine is turned on, ambient air is drawn into the canister system 100 through the vent port 105. The purge air flows through the subsequent adsorbent volume 202 and then the initial adsorbent volume 201, and desorbs the fuel vapor

adsorbed on the adsorbent volumes 202, 201 before entering an internal combustion engine through the purge outlet 106.

Id. at 4:29–40.

The embodiment of Figure 2 includes additional subsequent adsorbent volumes 203 and 204, and the embodiment of Figure 3 adds empty volume 205 between subsequent adsorbent volumes 203 and 204. *Id.* at 4:41–57.

Figures 4–6 of the '553 patent, reproduced below, depict a second group of canister system embodiments.



Figures 4–6 are evaporative emission control canister systems that include more than one canister, “wherein an initial adsorbent volume and at least one subsequent adsorbent volume are located in separate canisters that are connected to permit sequential contact by fuel vapor.” *Id.* at 4:14–20.

Figure 4 depicts main canister 101 having similar elements as shown in Figure 2, along with supplemental canister 300 including conduit 107 connected to main canister 101, subsequent adsorbent volume 301, and vent port 105. *Id.* at 4:61–5:3. Main canister 101 and supplemental canister 300 operate similarly to the embodiments of Figures 1–3: when the engine is off, fuel vapor enters main canister 101 through inlet 104, diffuses through the

adsorbent volumes 201–204, and then enters adsorbent volume 301 before releasing to the atmosphere at vent port 105. *Id.* at 5:4–14. Once the engine is turned on, ambient air is drawn into the canister system through vent port 105, the purge air flows through the adsorbent volumes in supplemental canister 300 and main canister 101 to desorb the fuel vapor adsorbed on the adsorbent volumes, before entering the internal combustion engine through purge outlet 106. *Id.* at 5:14–23. The embodiment of Figure 5 includes additional subsequent adsorbent volume 302, and the embodiment of Figure 6 adds empty volume 304 between subsequent adsorbent volumes 302 and 303. *Id.* at 5:24–38.

The '553 patent further discloses “the evaporative emission control system may include a heat unit for heating the purge air, at least one subsequent adsorbent volume, or both,” in order to enhance the purge efficiency. *Id.* at 12:29–34. “The heat input units may include, but are not limited to, internal resistive elements, external resistive elements, or heat input units associated with the adsorbent.” *Id.* at 13:29–31.

The '553 patent describes adsorbent volumes in terms of three adsorptive characteristics: “incremental adsorption capacity,” “butane working capacity (BWC),” and “g-total BWC.” *Id.* at 6:10–22. These properties are described as “nominal,” which includes adsorbent component volumes but excludes conduits, gaps, or other non-adsorbent volumes, and “effective,” which includes all volumes of the system both adsorbent and non-adsorbent. *Id.* at 6:37–42; 10:26–34. Nominal incremental adsorption capacity of an adsorbent component is a function of the difference between the gram mass of adsorbed butane at 50 vol. % butane concentration and 5 vol. % butane concentration, multiplied by the “nominal volume apparent

density” (defined as the mass of adsorbent material divided by the nominal volume of adsorbent material). *Id.* at 6:56–64; 9:6–25. Nominal volume BWC is determined by placing the adsorbent component in a test system that loads the adsorbent material with butane and then purges it with air, and measuring the difference in mass of the adsorbent component before and after the purge. *Id.* at 9:26–10:24. The g-total BWC is defined as the total gram amount of butane purged during the test. *Id.* at 10:24–25. The “effective” property of each characteristic (i.e., effective incremental adsorption capacity, effective butane working capacity (BWC), and effective g-total BWC) is a function of each respective nominal property that takes into account the total effective volume of the system. *Id.* at 10:25–62.

The ’553 patent provides an exemplary embodiment of an evaporative emission control canister system with specified adsorbent material properties, comprising:

an initial adsorbent volume having an effective incremental adsorption capacity at 25° C. of greater than 35 grams n-butane/L between vapor concentration of 5 vol % and 50 vol % n-butane; and at least one subsequent adsorbent volume having an effective incremental adsorption capacity at 25° C. of less than 35 grams n-butane/L between vapor concentration of 5 vol% and 50 vol% n-butane, an effective butane working capacity (BWC) of less than 3 g/dL, and a g-total BWC of between 2 grams and 6 grams. . . .

The evaporative emission control canister system has a two-day diurnal breathing loss (DBL) emissions of no more than 20 mg at no more than about 210 liters of purge applied after the 40 g/hr butane loading step.

Id. at 3:56–67; 4:5–9.

The '553 patent provides further examples of evaporative emission control canister systems, and lists specific characteristics for each example. *Id.* at 13:60–20:12; *see also* col. 19–col. 24, Tables 1–5.

C. The Challenged Claims

Petitioner challenges claims 1–10, 14–28, 32–38, 51, 52, 55–57, 59, 64–72, and 76–82 of the '553 patent (“the challenged claims”). Pet. 1. Claims 2–10 and 14–20 depend from claim 1; claims 22–28 and 32–38 depend from claim 21; claim 52 depends from claim 51; claims 56, 57, and 59 depend from claim 55; and claims 65–72 and 76–82 depend from claim 64.

Claim 1, reproduced below with additional paragraphing to separate the limitations at issue in this Decision, is illustrative of the subject matter of the challenged claims:

1. An evaporative emission control canister system,
including one or more canisters and comprising:

[A]¹ a fuel-side adsorbent volume having an effective incremental adsorption capacity at 25° C. of greater than 35 grams n-butane/L between vapor concentration of 5 vol % and 50 vol % n-butane; and

[B] at least one subsequent adsorbent volume having an effective incremental adsorption capacity at 25° C. of less than 35 grams n-butane/L between vapor concentration of 5 vol % and 50 vol % n-butane,

[C] an effective butane working capacity (BWC) of less than 3 g/dL, and

[D] a g-total BWC of ≤ 6 grams,

¹ We label each of the relevant claim limitations with the lettering the parties apply in the Petition and Patent Owner Response.

[E] wherein the fuel-side adsorbent volume having an effective incremental adsorption capacity at 25° C. of greater than 35 grams n-butane/L between vapor concentration of 5 vol % and 50 vol % n-butane, and the at least one subsequent adsorbent volume are located within a single canister, or in separate canisters that are connected to permit sequential contact by fuel vapor, and

[F1] wherein the canister system has a two-day diurnal breathing loss (DBL) of no more than 20 mg at no more than 100 BV of purge applied after a 40 g/hr butane loading step.

Id. at 23:18–40.

D. Asserted Grounds of Unpatentability

Petitioner asserts the following grounds of unpatentability:

Claims Challenged	35 U.S.C. ²	Reference(s)/Basis
1–10, 14–28, 32–38, 51, 52, 55–57, 59, 64–72, and 76–82	§ 112(b)	Indefiniteness
1–10, 14–28, 32–38, 51, 52, 55–57, 59, 64–72, and 76–82	§ 103(a)	Hiltzik, ³ Clontz WIPO, ⁴ and Clontz SAE ⁵

Pet. 3. Petitioner relies on the Declaration of James M. Lyons (Ex. 1003) (“Lyons Declaration”) and Reply Declaration by James M. Lyons (Ex. 1042) (“Lyons Reply Declaration”). Patent Owner relies on the Revised Declaration of Dr. David A. Rockstraw in Support of Patent Owner

² The Leahy-Smith America Invents Act (“AIA”) included revisions to 35 U.S.C. § 103 that became effective on March 16, 2013. As discussed below (II.C), we determine that the ’553 patent issued from an application that has an effective filing date after March 16, 2013, and, thus, we apply the AIA versions of the statutory bases for unpatentability.

³ US Patent No. RE38,844 E to Hiltzik et al., issued Oct. 25, 2005 (Ex. 1007).

⁴ WO 2009/061533 A1 to Clontz et al., published May 14, 2009 (Ex. 1009).

⁵ Clontz, R., *et al.*, “Effects of Low-Purge Vehicle Applications and Ethanol-Containing Fuels on Evaporative Emissions Canister Performance,” Society of Automotive Engineers of Japan (2007) (Ex. 1010).

Response (Ex. 2022) (“Rockstraw Declaration”) and the Revised Declaration of Roger Williams in Support of Patent Owner Response (Ex. 2027).

II. ANALYSIS

A. *Level of Ordinary Skill in the Art*

Factors pertinent to a determination of the level of ordinary skill in the art include “(1) educational level of the inventor; (2) type of problems encountered in the art; (3) prior art solutions to those problems; (4) rapidity with which innovations are made; (5) sophistication of the technology; and (6) educational level of workers active in the field.” *Envtl. Designs, Ltd. v. Union Oil Co.*, 713 F.2d 693, 696–697 (Fed. Cir. 1983) (citing *Orthopedic Equip. Co. v. All Orthopedic Appliances, Inc.*, 707 F.2d 1376, 1381–82 (Fed. Cir. 1983)). Not all such factors may be present in every case, and one or more of these or other factors may predominate in a particular case. *Id.*

Petitioner argues a person of ordinary skill in the art at the time of the invention “would possess at least a B.S. in chemistry or chemical or mechanical engineering and would have at least one year of experience working on control of automotive evaporative emissions,” and “would also understand the chemistry and physics associated with the phenomena of fuel vapor adsorption, desorption, and diffusion.” Pet. 28 (citing Ex. 1003 ¶ 17). Patent Owner does not dispute the level of ordinary skill in the art. We adopt Petitioner’s definition of the level of ordinary skill in the art because it is consistent with the ’553 patent and the asserted prior art.

B. *Principles of Law*

“[A] patent is invalid for indefiniteness if its claims, read in light of the specification . . . and the prosecution history, fail to inform, with

reasonable certainty, those skilled in the art about the scope of the invention.” *Nautilus, Inc. v. Biosig Instruments, Inc.*, 572 U.S. 898, 901 (2014); see *Memorandum on the Approach to Indefiniteness Under 35 U.S.C. § 112 in AIA Post-grant Proceedings* (Jan. 6, 2021), <https://www.uspto.gov/sites/default/files/documents/IndefinitenessMemo.pdf>.

A claim is unpatentable under 35 U.S.C. § 103 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 ordinary skill in the art; and (4) when available, evidence such as commercial success, long felt but unsolved needs, and failure of others. *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966); see *KSR*, 550 U.S. at 407 (“While the sequence of these questions might be reordered in any particular case, the [Graham] factors continue to define the inquiry that controls.”).

The Supreme Court made clear that we apply “an expansive and flexible approach” to the question of obviousness. *KSR*, 550 U.S. at 415. Whether a patent claiming the combination of prior art elements would have been obvious is determined by whether the improvement is more than the predictable use of prior art elements according to their established functions. *Id.* at 417. Reaching this conclusion, however, requires more than merely

showing that the prior art includes separate references covering each separate limitation in a challenged claim. *Unigene Labs., Inc. v. Apotex, Inc.*, 655 F.3d 1352, 1360 (Fed. Cir. 2011). Rather, obviousness additionally requires that a person of ordinary skill at the time of the invention “would have selected and combined those prior art elements in the normal course of research and development to yield the claimed invention.” *Id.*

In a post-grant review, Petitioner bears the ultimate burden of persuasion regarding unpatentability, which never shifts to Patent Owner. *See Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1379 (Fed. Cir. 2015) (discussing petitioner’s burden of proving unpatentability in *inter partes* review); *RetailMeNot, Inc. v. Honey Science Corp.*, PGR2019-00060, Paper 17 at 7–8 (PTAB Mar. 10, 2020) (petitioner has the burden of demonstrating eligibility for post-grant review).

C. Post-Grant Review Eligibility of the ’553 Patent

The post-grant review provisions set forth in section 6(d) of the Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (September 16, 2011) (“AIA”), apply only to patents subject to the first-inventor-to-file provisions of the AIA. *See* AIA § 6(f)(2)(A) (The provisions of Section 6(d) “shall apply only to patents described in section 3(n)(1)”). Patents subject to the first-inventor-to-file provisions are those that issue from applications “that contain[] or contained at any time . . . a claim to a claimed invention that has an effective filing date as defined in section 100(i) of title 35, United States Code, that is on or after” March 16, 2013. AIA § 3(n)(1). Additionally, “[a] petition for a post-grant review may only be filed not later than the date that is 9 months after the date of the

grant of the patent or of the issuance of a reissue patent (as the case may be).” 35 U.S.C. § 321(c).

In the Institution Decision, we determined that Petitioner sufficiently showed the ’553 patent is eligible for post-grant review because the earliest potential effective filing date is October 10, 2013. Neither party has challenged that determination during trial. Accordingly, for purposes of this Decision, we do not further consider eligibility of the ’553 patent for post-grant review.

D. Indefiniteness of the Challenged Claims

1. The Parties’ Contentions⁶

Petitioner argues that claims 1–10, 14–28, 32–38, 51, 52, 55–57, 59, 64–72, and 76–82 are indefinite under 35 U.S.C. § 112(b). Pet. 41–56.

Petitioner contends the term “effective incremental adsorption capacity (IAC)” in the challenged claims is indefinite, because the ’553 patent discloses two different methods for calculating effective IAC, McBain (using gravimetric instruments) and ASAP 2020 (using volumetric instruments), which Petitioner contends result in substantially different values for IAC, and a person of ordinary skill in the art would not have known which method to select. Pet. 43–44 (citing *Dow Chem. Co. v. Nova Chems. Corp.*, 803 F.3d 620 (Fed. Cir. 2015); *Teva Pharms. USA, Inc. v. Sandoz, Inc.*, 789 F.3d 1335, 1344–45 (Fed. Cir. 2015)). Petitioner presents argument and evidence concerning testing by a third party, Intertek, of three

⁶ Several of the exhibits discussed herein were the subject of motions to seal, which we granted in an Order dated July 22, 2021 (Paper 73). We do not discuss any of the confidential information contained in any sealed portion of those exhibits in this Decision.

different adsorbent materials under both methods, and asserts that the methods produce a potential 12–14 % difference in effective IAC. Pet. 47–48, 52 (citing Ex. 1003 ¶¶ 112–117, 128; Ex. 1020; Ex. 1035 ¶¶ 4–13).

Patent Owner contends adsorption capacity is a physical parameter that is fixed for an adsorbent-adsorbate system, provided that the adsorbate identity, concentration, and temperature are fixed, i.e. specifying these three outcome-determinative variables in turn fixes the adsorption capacity for a given adsorbent. PO Resp. 72 (citing Ex. 2022 ¶¶ 59–67; Ex. 2056, 40:10–12; Ex. 2071 ¶ 54). Patent Owner thus contends effective IAC as recited in the '553 patent claims is a fundamental property independent of measurement technique, which is confirmed by the fact that equivalent adsorption capacities can be measured using different measurement techniques. *Id.* at 73. Patent Owner and Dr. Rockstraw rely on several peer-reviewed publications as evidence that gravimetric and volumetric instruments measure equivalent adsorption capacities if the instruments are accurate and proper laboratory protocols are observed. *Id.* at 73–74 (citing Ex. 2007; Ex. 1021; Ex. 2069; Ex. 2022 ¶¶ 95–103, 109–116). Patent Owner also contends Petitioner fails to show that the McBain and ASAP 2020 methods, as analyzed by Intertek, provide fundamentally different measurements of adsorption capacity (*id.* at 75–81) and asserts that the differences in the measurements in the Guo Memo (Ex. 1041) are attributable to instrument inaccuracies and experimental error. *Id.* at 81–85.

In its Reply, Petitioner argues “[a]ll of the evidence shows significant differences between adsorption capacity results measured using different instruments.” Pet. Reply 27. Petitioner contends the Guo Memo’s conclusion confirms that the methods yield significantly different

measurements (*id.* at 24–25) and that Intertek’s results also confirm substantial differences in the McBain and ASAP 2020 results. *Id.* at 25–26. Petitioner also argues the peer-reviewed papers relied upon by Patent Owner do not address adsorption capacity determinations regarding n-butane, and also confirm that different measurement methods produce different results.

2. Discussion

Upon review of the parties’ arguments and evidence, we determine Petitioner has not shown by a preponderance of the evidence that the gravimetric and volumetric methods provide fundamentally different measurements of adsorption capacity.

Patent Owner and Dr. Rockstraw present peer-reviewed scientific literature demonstrating that gravimetric and volumetric measurement techniques were known to measure equivalent adsorption capacities and were viewed as compatible with each other. *See* Ex. 2022 ¶¶ 95–107 (addressing Anson⁷ (Ex. 2007), Belmabkhout⁸ (Ex. 1021), Zielinski⁹ (Ex. 2069)). For example, Belmabkhout reported similar results between measurements by gravimetric and volumetric instruments, except at very high pressures. Ex. 1021, 856–57. Zielinski reported “excellent agreement” between volumetric and gravimetric adsorption capacity measurements (Ex. 2069, 5–6); Dr. Zielinski (who oversaw the testing reported by Intertek

⁷ Anson, A., *et al.*, “Hydrogen adsorption on a single-walled carbon nanotube material: a comparative study of three different adsorption techniques,” *Nanotechnology* 15 (2004), 1503.

⁸ Belmabkhout, Y., *et al.*, “High-pressure adsorption measurements. A comparative study of the volumetric and gravimetric methods,” *Measurement Science and Technology* 15 (2004) 848.

⁹ Zielinski, J. *et al.*, “High pressure sorption isotherms via differential pressure measurements,” *Adsorption* 13 (2007), 1–7.

in Ex. 1020) also testified that he would expect capacity measurements for either a gravimetric or volumetric technique to yield the same results, or be “superimposable” under ideal conditions, because they represent “the same experimental measured quantities.” Ex. 2026, 52:11–53:7, 54:13–22, 69:12–70:3, 139:8–19.

Petitioner’s argument that these papers are not relevant because they do not address measurements on the adsorption capacity of n-butane (*see* Pet. Reply 26) is not persuasive, because Petitioner does not direct us to sufficient evidence showing a reason why measurements of n-butane’s adsorption capacity would have been subject to different measurement inconsistencies. Further, Petitioner’s argument about a 3% deviation in results between the measurement techniques reported in Anson and Belmabkhout is not persuasive because the papers’ conclusions suggest a person of ordinary skill in the art would not have seen such a deviation as significant (e.g., Ex. 1021, 849: “we have not observed important discrepancies” between gravimetric and volumetric measurements).

Dr. Rockstraw also testifies as to numerous additional texts and standards that confirm persons of ordinary skill in the art understood that gravimetric and volumetric measurement techniques would provide consistent results when proper experimental protocols are followed and the instruments’ accuracy and precision are taken into consideration. *See* Ex. 2022 ¶¶ 88–91, 119–127. This evidence is essentially un rebutted by Petitioner. We find that the evidence submitted by Patent Owner as to the gravimetric and volumetric measurement techniques demonstrates that they were well established in the art as comparable methods of measuring adsorption capacity, and accordingly, not a basis for determining claim

indefiniteness. *See Presidio Components, Inc. v. Am. Technical Ceramics Corp.*, 875 F.3d 1369, 1377 (Fed. Cir. 2017) (explaining that where the test methodology was sufficiently well established in the art, “disputes between the parties as to the proper application of the test methodology in the circumstances of an individual case ... are disputes about whether there is infringement, not disputes about whether the patent claims are indefinite).

Because this determination is dispositive as to Petitioner’s indefiniteness challenge, we need not address Petitioner’s allegations as to the measurement differences reported by Intertek in Exhibit 1020. For the reasons discussed above, Petitioner has not established indefiniteness of the challenged claims by a preponderance of the evidence.

E. Obviousness Based on Hiltzik, Clontz WIPO, and Clontz SAE

1. Overview of the Asserted References

Hiltzik (Ex. 1007)

Hiltzik relates to “a method for reducing emissions from evaporative control systems including activated carbon particulate-filled canisters and adsorptive monolith-containing canisters.” Ex. 1007, 1:14–19. Hiltzik describes “the use of multiple beds (or layers, stages, or chambers) of adsorbent materials, which, in combination, significantly reduce [diurnal breathing loss] emissions while maintaining the high working capacity and low flow restriction properties of the canister system.” *Id.* at 4:9–13.

Figure 2 of Hiltzik is reproduced below.

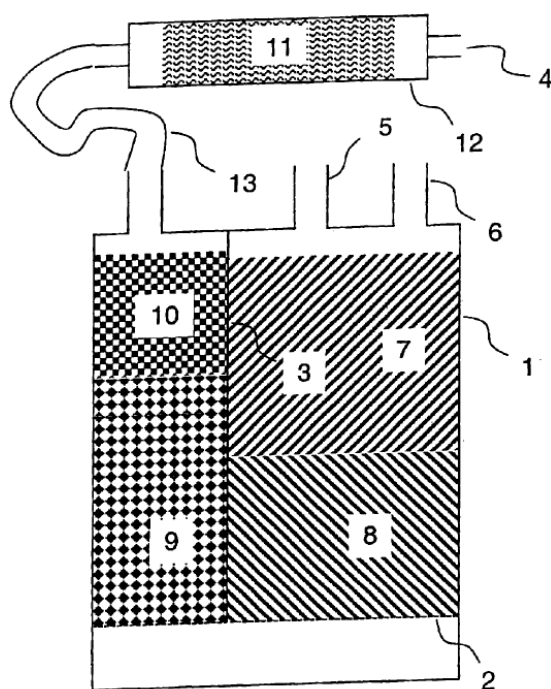


FIGURE 2

Figure 2 depicts an exemplary embodiment of a canister system with multiple adsorbents. *Id.* at 6:31–32. The canister system comprises primary canister body 1, support screen 2, dividing wall 3, vent port 4 to the atmosphere, vapor source connection 5, vacuum purge connection 6, fuel source-side region 7, vent-side canister regions 8–11 of varying low-capacities, supplemental canister body 12, and connecting hose 13 permitting fluid stream flow from primary canister body 1 to supplemental canister body 12. *Id.* at 6:33–40. Hiltzik describes several examples of the canister system, including Example 2, a system using a honeycomb structure as the adsorbent bed in the supplemental canister body 12. *Id.* at 6:55–57; 7:6–67. Hiltzik describes measuring the diurnal breathing loss (DBL) emissions for each example, and provides the emission performance results. *Id.* at 6:50–7:5; col. 8, Table. In one specific embodiment, Hiltzik describes a canister system comprising:

the initial volume of vapor adsorbent material is characterized by an incremental adsorption capacity at 25° C. of greater than 35 g n-butane/L between vapor concentrations of 5 vol % and 50 vol % n-butane before routing the fluid stream through at least one subsequent volume of vapor adsorbent material[, and] wherein the subsequent volume of vapor adsorbent material is characterized by an incremental adsorption capacity at 25° C. of less than 35 g n-butane/L between vapor concentrations of 5 vol % and 50 vol % n-butane.

Id. at 9:33–42.

Hiltzik also discloses example butane working capacities (BWC) for the system of about 6 g/dL or less (*id.* at 5:2–5, 8:49) and a two-day DBL of 10–29 mg at 150 BV purge (*id.* at 8:33–35).

Clontz WIPO (Ex. 1009)

Clontz WIPO relates to “a hydrocarbon emissions scrubber, and to using the scrubber to remove volatile organic compounds, and other chemical agents from fluid streams.” Ex. 1009 ¶ 1. Clontz WIPO refers to Hiltzik (Ex. 1007) in the Description of Related Art section, and notes

[a]lthough the adsorbents-in-series as taught in [Hiltzik] are effective for substantial reductions in bleed emissions for typical vehicle designs and engine operation, recent designs of [hybrid] vehicle engines for improved fuel efficiency . . . do not achieve comparable reductions in emissions in some instances even with adsorbents-in-series in the evaporative emission control system.

Id. ¶ 6. Clontz WIPO explains

[t]hese [hybrid] engine designs do not provide enough volume of purge during carbon regeneration in order to sufficiently reduce the amount or alter the distribution of residual hydrocarbon heel in the carbon bed for the needed low levels of emissions during subsequent diurnal breathing conditions.

Id. ¶ 6. Clontz WIPO discloses

the use of multiple stages or chambers of electrically heatable adsorbent monoliths or honeycombs, which, in combination with conventional evaporative emission control canisters, significantly reduces DBL emissions under low purge flow conditions while maintaining the high working capacity and low flow restriction properties of the canister system.

Id. ¶ 17. Figure 3 of Clontz WIPO is reproduced below.

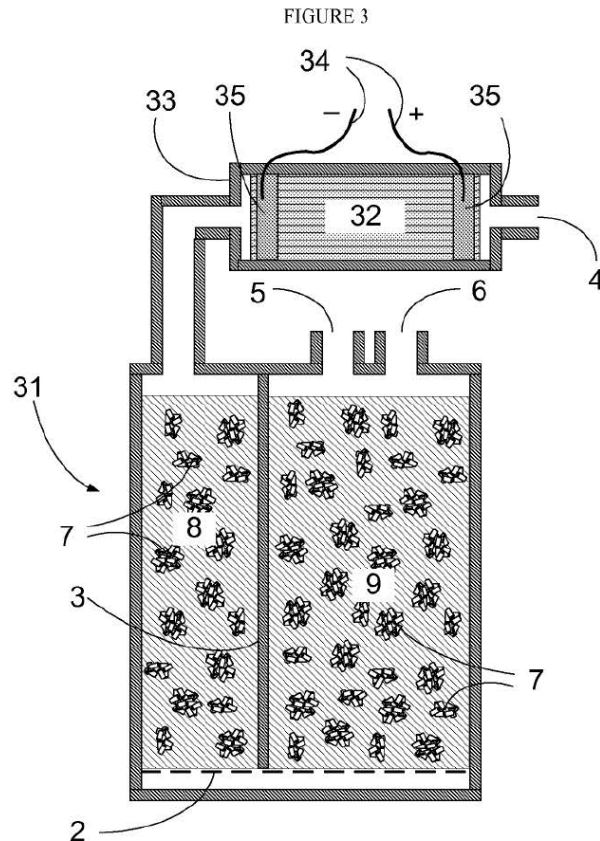


Figure 3 depicts an exemplary embodiment of a canister with multiple adsorbents. *Id.* ¶ 18. “The vapor flow path has an emission control system canister 31 in-line with an auxiliary canister 33 containing a bleed emission adsorbent scrubber 32 with desirable resistivity properties.” *Id.*

Clontz WIPO discloses several examples of the canister system (“Example 1”, “Example 2,” and “Example 3”) using an electrically

conductive carbon honeycomb structure. *Id.* ¶¶ 21–26. Clontz WIPO describes measuring the diurnal breathing loss (DBL) emissions for each example, and provides the emission performance results. *Id.* at Table I, Table II.

Clontz SAE (Ex. 1010)

Clontz SAE is titled “Effects of Low-Purge Vehicle Applications and Ethanol-Containing Fuels on Evaporative Emissions Canister Performance,” and is directed to “optimiz[ing] the use of the activated carbon honeycomb [in evaporative emissions canisters] under reduced purge conditions and under conditions of exposure to fuels of different volatility and ethanol content.” Ex. 1010, Title, 1713–14. Clontz SAE analyzes the effect of several factors on diurnal emissions, including canister purge volume, activated carbon honeycomb configuration, and resistive heating of a honeycomb. *Id.* at 1713. Figure 3 of Clontz SAE is reproduced below.

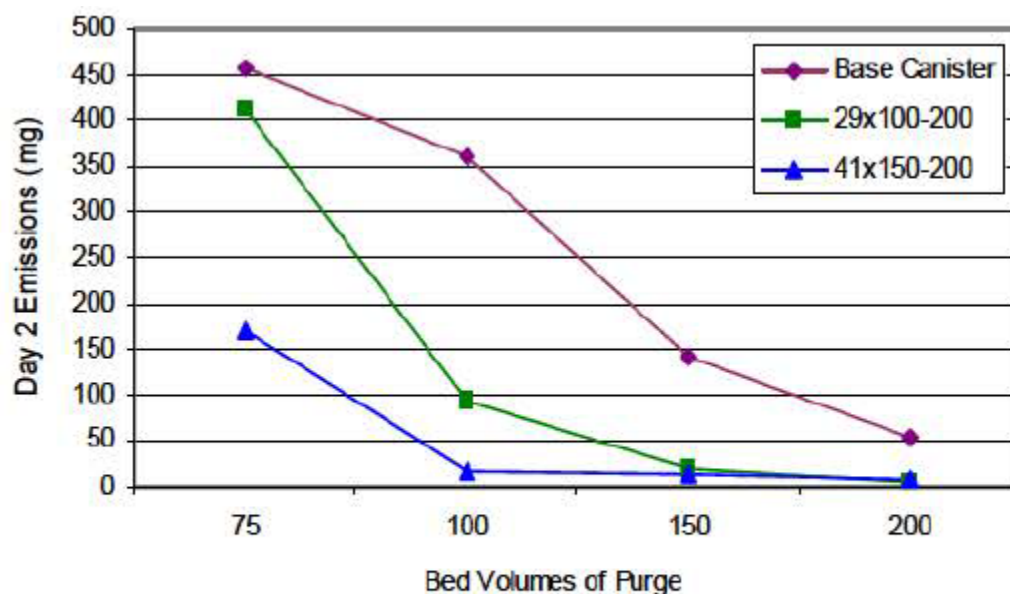


Figure 3. Effect of Purge volume with base canister and commercially available honeycombs.

Figure 3, reproduced above, is a graph depicting the relationship between purge volume and emissions for activated carbon honeycombs of two different sizes, 29 x 100 mm and 41 x 150 mm, and a base canister.

Clontz SAE provides results for additional honeycomb configurations in Figure 4, reproduced below.

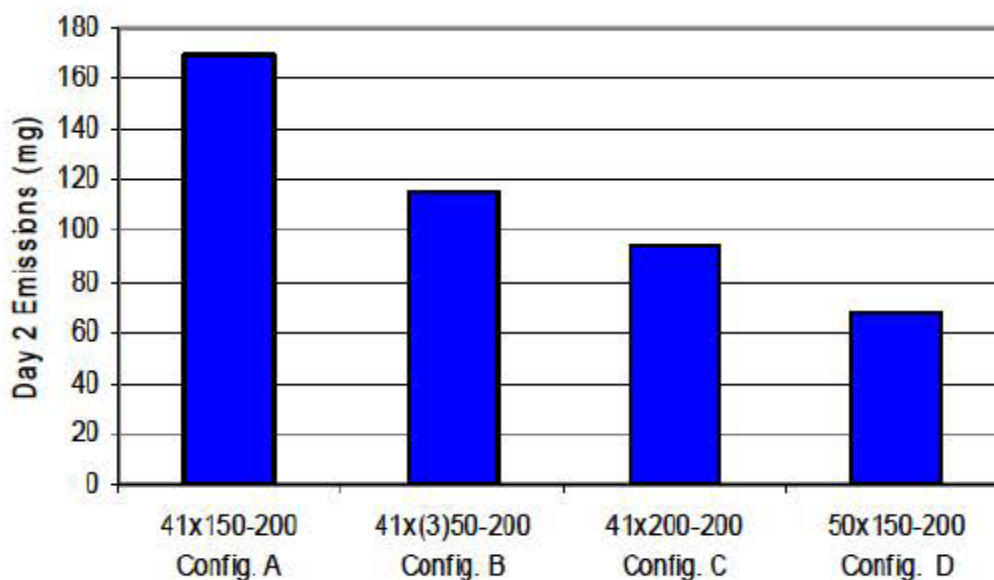


Figure 4. Summary of emissions results obtained with alternate honeycomb configurations with 75 bed volumes of purge.

Figure 4, reproduced above, is a bar chart illustrating the results of two-day diurnal emissions tests for four different activated carbon honeycomb configurations: Config. A (single honeycomb of 41 mm diameter x 150 mm length); Config. B (three honeycombs of 41 mm diameter x 50 mm length in series); Config. C (single honeycomb of 41 mm diameter x 200 length); and Config. D (single honeycomb of 50 mm diameter x 150 length). *Id.* at 1716. Clontz SAE explains “[t]he emissions data show that the developmental honeycomb Configurations (B-D) reduced emissions as compared to the

baseline Configuration A (41 x150). These improvements ranged from 32% to 60% depending on honeycomb geometry and size.” *Id.* at 1716. Clontz SAE further discloses “[h]oneycomb Configurations C (41x200) and D (50x150) showed approximately 45% and 60% improvement as compared to the baseline Configuration A,” and “[b]oth of these honeycomb configurations have more total working capacity due to their larger size as compared to the baseline honeycomb.” *Id.* at 1717.

Clontz SAE also discloses the effect of resistive heating of an activated carbon honeycomb on diurnal emissions, as shown in Figure 6, reproduced below. *Id.*

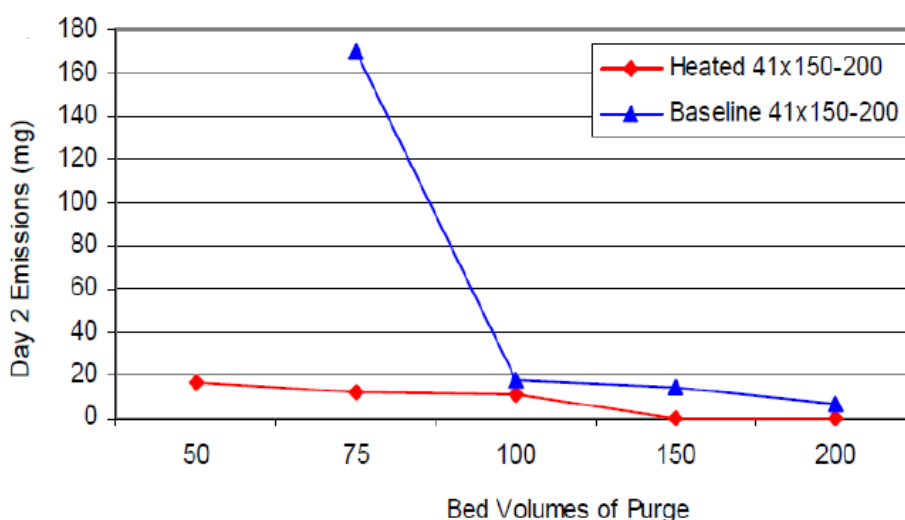


Figure 6 of Clontz SAE

Figure 6 is a graph illustrating emissions measured with the heated activated carbon honeycomb were lower as compared to the non-heated honeycomb. *Id.* Clontz SAE explains that “[t]he improvement in performance was most dramatic at lower purge volumes,” and “[r]esistively heating the honeycomb allowed emissions of less than 20 mg for all levels of purge evaluated.” *Id.*

2. Analysis

Claim 1

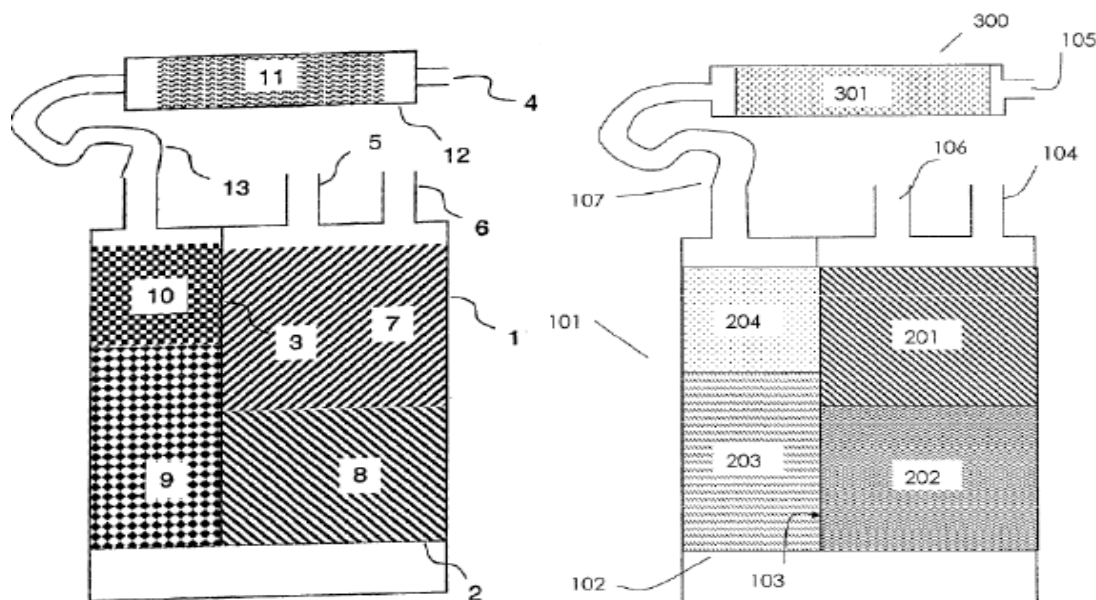
Petitioner contends claim 1 of the '553 patent would have been obvious over the combination of Hiltzik, Clontz WIPO, and Clontz SAE. Pet. 56–88. Patent Owner contends claim 1 would not have been obvious over Petitioner's proposed combination, generally because Hiltzik, the only reference that discloses values for effective working capacity, does not address a low purge system as required by claim limitation [F1], and Clontz WIPO and Clontz SAE do not teach lower working capacity properties as required by limitations [C] and [D]. PO Resp. 9. Patent Owner further contends a person of ordinary skill in the art would not have been motivated to combine or modify Hiltzik with Clontz WIPO and Clontz SAE as Petitioner proposes, to achieve a canister system that meets the low purge requirement of limitation [F1] while also including a subsequent adsorbent volume that meets the requirements of limitations [C] and [D]. *Id.* at 9–10. For the reasons that follow, we determine that Petitioner has not established by a preponderance of the evidence that Petitioner's proposed combination teaches or suggests limitations [C], [D], and [F1]. Because these findings are dispositive, we focus our discussion on these limitations. To provide context, however, we initially discuss Petitioner's contentions as to the non-dispositive limitations and general reasons to combine or modify the references, and Patent Owner's response to those general reasons.

Petitioner contends each of Hiltzik, Clontz WIPO, and Clontz SAE teach an evaporative emission control canister system including one or more canisters. Pet. 67–69 (citing Ex. 1007, Abstract, Fig. 2; Ex. 1009, Abstract, Fig. 3; Ex. 1010, Title). Petitioner contends a person of ordinary skill in the

art would have been motivated to combine Hiltzik, Clontz WIPO, and Clontz SAE because each reference relates to a canister system having the same basic configuration, and discloses that the use of a honeycomb significantly reduces DBL emissions. *Id.* at 65. Petitioner further contends Clontz WIPO and Clontz SAE demonstrate a need to control DBL emissions in low-purge vehicles, and provide different data sets that a person of ordinary skill in the art would have consulted for low-purge emissions levels for two sizes of honeycombs, although Petitioner acknowledges neither reference discloses IAC or BWC of the honeycombs tested. *Id.* at 66. Petitioner contends a person of ordinary skill in the art would have understood that Hiltzik's nominal IAC and BWC values could be used with Clontz WIPO and Clontz SAE, in part because Clontz WIPO references Hiltzik's discussion of honeycomb properties and discloses that its honeycomb was created using the same method as Hiltzik's honeycomb. *Id.*

Petitioner contends Hiltzik discloses an initial volume of vapor adsorbent material having the properties recited in limitation [A]. Pet. 70–71 (citing Ex. 1007; Ex. 1003 ¶¶ 160–164.) Petitioner contends Hiltzik's initial adsorbent volume is a fuel-side adsorbent volume, as illustrated in side-by-side figures from Hiltzik and the '553 patent:

FIGURE 2



Pet. 68. The figure above shows Figure 2 of Hiltzik on the left and Figure 4 of the '553 patent on the right. Hiltzik's initial adsorbent volume 7 is in the same position as fuel-side adsorbent volume 201 of Figure 4 of the '553 patent. Pet. 70 (citing Ex. 1001, 4:29–34; Ex. 1007, 6:34–35). Petitioner contends that Hiltzik's Examples 1–3 include a fuel-side layer of BX 1500 pellets having an IAC of 80 g/L, which is within the claimed range for effective IAC. *Id.* (citing Ex. 1007, 6:52; Ex. 1003 ¶ 163).

Petitioner further contends Hiltzik, Clontz WIPO, and Clontz SAE teach a subsequent adsorbent volume in the form of a honeycomb monolith, and the combination of Hiltzik, Clontz WIPO, and Clontz SAE teaches the use of a subsequent adsorbent volume having the properties recited in limitation [B]. Pet. 71–72 (citing Ex. 1003 ¶¶ 166–68). Petitioner acknowledges that none of the references explicitly discloses the “effective IAC” value for its honeycomb, but contends a person of ordinary skill in the art would have been motivated by Hiltzik's teaching of nominal IAC less

than 35 g/L to use honeycomb adsorbent having effective IAC in the recited range. *Id.* at 65–66, 73–74 (citing Ex. 1003 ¶¶ 154-55, 170). Petitioner contends a person of ordinary skill in the art would have understood that Hiltzik’s nominal IAC corresponds to effective IAC (as recited in claim 1) because Hiltzik’s measurement of IAC does not encompass non-adsorbent empty spaces. *Id.* at 73 (citing Ex. 1003 ¶ 170).

[C] an effective butane working capacity (BWC) of less than 3 g/dL, and

[D] a g-total BWC of ≤ 6 grams

[F1] wherein the canister system has a two-day diurnal breathing loss (DBL) of no more than 20 mg at no more than 100 BV of purge applied after a 40 g/hr butane loading step.

Petitioner contends Hiltzik teaches nominal BWC of 4g/dL for its honeycomb adsorbent (Example 2) and that “lower capacity adsorbents have BWC values preferably below 8 g/dL.” Pet. 75 (citing Ex. 1007, 6:2–8, 8:49). Petitioner acknowledges that none of the references explicitly discloses the “effective BWC” value for its honeycomb, but contends a person of ordinary skill in the art would have understood the relationship of Hiltzik’s nominal BWC to claim 1’s effective BWC for the same reason as effective IAC, discussed above. *Id.* (citing Ex. 1003 ¶¶ 154-55, 176–77). Petitioner contends a person of ordinary skill in the art would understand that reducing effective BWC below 3 g/dL would also achieve g-total BWC ≤ 6 grams for the 200 ml honeycomb of Hiltzik’s Example 2. Pet. 83–84.

Petitioner contends Clontz WIPO teaches that canister systems with 66 mL honeycomb adsorbents meet the performance requirement of limitation [F] when a heating element is applied to the honeycomb. Pet. 87–88 (citing Ex. 1009, Table II). Petitioner further contends Clontz SAE

confirms that heating elements drastically reduce the 2-day DBL emissions. *Id.* (citing Ex. 1010, Fig. 6). Petitioner contends a person of ordinary skill would have been motivated to apply a heating element as taught by Clontz SAE to the honeycomb adsorbent, resulting in emissions within the recited range below 20mg at no more than 100BV of purge. *Id.*

Petitioner contends a person of ordinary skill in the art would have been motivated to modify Hiltzik's system to achieve an effective BWC of less than 3 g/dL and a g-total BWC of 6g or less, as required by limitations [C] and [D], by either (1) diluting Hiltzik's honeycomb¹⁰ or (2) including significant adsorbent-free, empty space preceding the honeycomb in the flow path between the main canister and the honeycomb adsorbent. Pet. 76, 80, 83–85. We first discuss the parties' contentions as to diluting Hiltzik's honeycomb.

Diluting Hiltzik's honeycomb

Petitioner contends a person of ordinary skill in the art would have been motivated to dilute Hiltzik's honeycomb because of (1) Hiltzik's teaching of using adsorbents with flatter isotherms, and using volumetric dilution (i.e., including voids that increase the percentage of volume coming from empty spaces) to flatten the isotherm; and (2) Clontz WIPO's teaching that reducing resistance of the honeycomb achieves lower emissions. *Id.* at

¹⁰ Dr. Lyons explains: “[A]ctivated carbons used in automotive applications ... can be mixed with other materials and extruded to form a pellet or monolith. This mixing reduces the amount of carbon in a given volume – a process known as dilution ... inclusion of spacers and voids in the carbon bed also impacts canister performance properties including adsorption capacity. Use of spacers and voids, can be considered another form of dilution because it reduces the amount of total carbon in the bed. Ex. 1003 ¶¶ 58–59.

77–78 (citing Ex. 1003 ¶¶ 178, 179, 186; Ex. 1007, 4:61–63, 6:23–26, 7:35–37, 7:44–50; Ex. 1009 ¶ 17, Table 2). Petitioner contends a person of ordinary skill in the art would have had a reasonable expectation of success in diluting the honeycomb (by either using non-adsorbent additives in the honeycomb material, or volumetric dilution), based on the same teachings of Hiltzik and Clontz WIPO. *Id.* at 78. Petitioner further contends Park¹¹ is evidence of the knowledge of a person of ordinary skill in the art relating to honeycomb design and the relationship between void percentage and dilution (*id.* at 78–79 (citing Ex. 1003 ¶¶ 181–83; Ex. 1007, 7:28–40; Ex. 1009 ¶ 21; Ex. 1024, 7:15–18)), and Gadkaree¹² is evidence that honeycombs with BWC less than 3g/dL were known. *Id.* at 79 (citing Ex. 1003 ¶ 184; Ex. 1023).

Petitioner contends a person of ordinary skill in the art would have understood, from Hiltzik’s teaching of nominal BWC of its honeycomb as discussed above, how to reduce g-total BWC below 6g, as required by limitation [D], because g-total BWC of an adsorbent volume is the sum of the product of nominal BWC and nominal volume for each adsorbent component in an adsorbent volume. *Id.* at 83–84 (citing Ex. 1003 ¶¶ 196–197). Petitioner explains how a person of ordinary skill would have been motivated to use the teaching of Hiltzik’s Example 2 honeycomb with Clontz SAE’s teachings that honeycombs with higher g-total BWC perform better at low purge, to achieve a 200-ml honeycomb having g-total BWC of 5.4g. *Id.* at 84 (citing Ex. 1003 ¶ 197; Ex. 1007, 8:21; Ex. 1010, 1717).

¹¹ U.S. Patent 5,914,294 to Park et al., issued June 22, 1999 (Ex. 1024).

¹² U.S. Patent 5,510,063 to Gadkaree et al., issued April 23, 1996 (Ex. 1023)

Petitioner further contends, as with effective BWC discussed above, that a person of ordinary skill in the art would have been motivated to combine Clontz WIPO's teaching of a smaller honeycomb to reduce g-total BWC to 2.6g. *Id.*

Patent Owner contends Petitioner's allegations as to limitations [C] and [D] fail to establish obviousness because "Petitioner has not established any basis for alleging that POSITA would have been motivated to reduce working capacity of Hiltzik's honeycomb." PO Resp. 13–14. Patent Owner refers to this as "Approach #1." *Id.* Patent Owner contends Hiltzik does not teach the desirability of diluting its adsorbent, that Clontz SAE and Clontz WIPO teach *increasing* working capacity, rather than reducing it, and that Clontz WIPO does not teach diluting a honeycomb to reduce its resistance. *Id.* at 16–17. We address each of these in turn.

Patent Owner contends Hiltzik's Examples 1–3 belie Petitioner's assertion that Hiltzik teaches desirability of diluting the vent-side adsorbent as much as possible. PO Resp. 20. Specifically, Petitioner asserts that Hiltzik presents each example as a viable option for reducing canister bleed emissions, and is silent as to whether the examples would be improved by further volumetric dilution, or whether Example 2 is preferred. *Id.* at 20–21 (citing Ex. 1007, 8:61–9:4, Table; Ex. 2022 ¶¶ 190–196). Patent Owner further contends Petitioner identifies no teaching in Hiltzik that an adsorbent volume with the flattest isotherm always results in lower emissions, and that flattening the isotherm "as much as possible" would not make sense in the context of Hiltzik because such an adsorbent would allow fuel vapors to pass through and result in increased emissions. *Id.* at 21–22 (citing Ex. 1003 ¶ 178; Ex. 1007, 5:45–55, 9:37–42, 10:36–44; Ex. 2022 ¶¶ 192, 194).

Patent Owner contends Clontz SAE's conclusion that in a low purge system "increased honeycomb working capacity" "improve[s] emissions performance" is contrary to limitations [C] and [D] and would have taught a person of ordinary skill in the art to do the opposite of what Petitioner asserts. PO Resp. 17–19 (citing Ex. 1010, 1717, 1720; Ex. 2022 ¶¶ 260–267). Patent Owner also contends Clontz SAE identifies a "strong relationship between purge volume and canister emissions" (Ex. 1010, 1716) and relies on Clontz SAE's statement that under "reduced purge volume conditions, current activated carbon canister and honeycomb configurations may not be adequate to meet" emissions requirements. *Id.* at 18 (citing Ex. 1010, 1720). Patent Owner asserts that a person of ordinary skill in the art would have understood this statement to include Hiltzik's honeycomb, because it was the most commonly-used evaporative emissions technology to satisfy regulations in 2007 (*see* Ex. 2027 ¶ 20).

Patent Owner contends Clontz WIPO would not have motivated a person of ordinary skill in the art to dilute Hiltzik's honeycomb in order to achieve lower BWC values, for several reasons. PO Resp. 22–25. Patent Owner asserts Clontz WIPO reiterates and closely follows Hiltzik's disclosure, and therefore relates to making a honeycomb as taught by Hiltzik, rather than further diluting Hiltzik's honeycomb. *Id.* at 22 (citing Ex. 1007; Ex. 1009 ¶ 17; Ex. 2022 ¶¶ 215–217). Patent Owner contends a person of ordinary skill in the art would have understood Clontz WIPO as relating to the benefits of resistively heating a honeycomb, which requires lower resistance, and that use of conductive additives would have been for the purpose of reducing resistivity, not to lower BWC. *Id.* at 23–24 (citing Ex. 1009 ¶¶ 23, 25, 26; Ex. 2022 ¶ 217–220).

Patent Owner contends Park does not support Approach #1 because its statement that a honeycomb voidage percentage of “desirably about 73.8%” was not in the context of an evaporative emissions system, such as Hiltzik, Clontz SAE, and Clontz WIPO. PO Resp. 26–27 (citing Ex. 1025, 7:15–18; Ex. 2022 ¶ 233. Rather, Patent Owner asserts, Park’s honeycomb applications include air intake of a fuel injected internal combustion engine, and the exhaust air stream of a xerographic device. *Id.* at 27 (citing Ex. 1024, 4:20–44; Ex. 2022 ¶¶ 236–240). Patent Owner contends a person of ordinary skill in the art would not have understood that a voidage percentage that is desirable for those applications would have been desirable for adsorbing evaporative emissions, and further notes that the Board previously found that considerations applicable to Park’s applications are different from considerations relevant to evaporative emissions. *Id.* (citing Ex. 2009, 17–18; Ex. 2010, 5–8; Ex. 2022 ¶¶ 235–240). Patent Owner further argues that Petitioner’s contention of a 73.8% to 85% voidage percentage is based on an inadequately supported “obvious to try” rationale. *Id.* at 28.

In its Reply, Petitioner contends Dr. Rockstraw’s deposition testimony in district court litigation involving Hiltzik is inconsistent with Patent Owner’s position here, and confirms that a person of ordinary skill would have been motivated to use honeycombs with BWC below 3g/dL. Pet. Reply 2–3. Specifically, Petitioner contends Dr. Rockstraw admitted a person of ordinary skill in the art would “understand the potential desirability” of reducing BWC below 3g/dL. *Id.* (citing Ex. 1043, 91:20–92:11; Ex. 1044, 106:2–12). Petitioner further contends Dr. Rockstraw’s testimony that a person of ordinary skill in the art would have been motivated to “explore all the boundaries of the system,” including the entire

claimed IAC range, supports its position that a person of ordinary skill would have recognized using volumetric dilution to flatten the isotherm of a subsequent adsorbent volume would reduce DBL emissions. *Id.* at 3 (citing Ex. 1042 ¶¶ 15–20; Ex. 1043, 85:14–89:23, 92:12–100:6; Ex. 1044 93:22–94:4, 106:12–108:8, 115:5–24).

Petitioner further contends in reply that Clontz SAE would not have dissuaded a person of ordinary skill from using low-capacity honeycombs, because its experimental data does not suggest a correlation between higher volumetric BWC and lower DBL emissions. Pet. Reply 5–6 (citing Ex. 1010, 1716–1718; Ex. 1042 ¶ 34; Ex. 1045, 74:1–4). Petitioner acknowledges Clontz SAE twice mentions increasing capacity, but argues its other disclosures suggest using volumetrically diluted honeycombs. *Id.* at 6 (citing Ex. 1010, 1716–17). Petitioner also argues Clontz WIPO emphasizes the benefits of volumetrically diluting a honeycomb to flatten the isotherm, and indicates that honeycombs smaller than those in Hiltzik and Clontz SAE can be used to reduce DBL emissions to acceptable levels. *Id.* at 7 (citing Ex. 1009 ¶ 17; Ex. 1042 ¶ 37).

Discussion

Having reviewed the parties’ arguments and evidence, we determine a preponderance of the evidence does not support Petitioner’s contention that a person of ordinary skill in the art would have been motivated to dilute the honeycomb of Hiltzik’s Example 2 in order to meet emissions standards at low-purge conditions in view of Clontz SAE and Clontz WIPO.

We find persuasive Patent Owner’s argument that Clontz SAE teaches, contrary to Petitioner’s proposed combination, that as compared to Hiltzik’s honeycomb, higher working capacity honeycombs “facilitate

achievement of target emissions levels under the reduced purge conditions.”

Ex. 1010, 1720. Clontz SAE’s Figure 3, demonstrating the relationship between purge volume and canister emissions, also teaches “the larger 41 mm x 150 mm honeycomb exhibited lower emissions levels than the 29 mm x 100 mm honeycomb at purge volumes of less than 200 bed volumes.”

Ex. 1010, 1716. Clontz SAE’s Figure 4, illustrating emissions test results for “Alternative Honeycomb Geometries,” compares the baseline Configuration A honeycomb¹³ described as the 41 x 150 mm “commercial part” to alternative “developmental honeycomb configurations” having larger volumes and concludes that Configurations C and D, “which have more total working capacity due to their larger size as compared to the baseline honeycomb,” “showed approximately 45% and 60% improvement [in emissions reduction] as compared to the baseline Configuration A.” *Id.* at 1717. The conclusion of this section of Clontz SAE states that changes to the baseline part including “increased honeycomb working capacity” will “improve emissions performance.” *Id.* at 1717. Clontz SAE repeats this statement in its ultimate conclusion, which states “higher capacity honeycombs,” among other factors, will “facilitate achievement of target emissions levels under the reduced purge conditions.” *Id.* at 1720. These conclusions are directly contrary to Petitioner’s contention that a person of ordinary skill in the art would have been motivated to reduce the capacity of

¹³ Petitioner acknowledges that Clontz SAE’s Configuration A has the same dimensions as Hiltzik’s Example 2 honeycomb: 41 x 150 mm, and that Clontz SAE uses the same canister system as Hiltzik’s Example 2. Pet. 59–60.

Hiltzik's Example 2 honeycomb in order to meet the emissions requirements of claim limitation [F1].

Moreover, Petitioner's argument that Clontz SAE suggests using volumetrically diluted honeycomb to meet low-purge emission standards (Pet. Reply 6 (citing Ex. 1010, 1716–1717)) is not supported by Clontz SAE. In fact, Clontz SAE never mentions dilution. The section of Clontz SAE cited by Petitioner, as discussed above, includes the evaluation of higher capacity honeycombs than Hiltzik's, and concludes that higher capacity honeycombs improve emissions performance at low purge. This is contrary to suggesting volumetric dilution of honeycomb to meet low-purge emission requirements.

Petitioner's own arguments as to Clontz SAE also partially contradict each other. Although Petitioner draws a distinction between g-total working capacity and effective or nominal BWC when arguing in its Reply that "Clontz SAE at most suggests a correlation between increased honeycomb **g-total** working capacity—not **effective** or **nominal** BWC—and reduced emissions under low purge" (Pet. Reply 6), this contradicts the Petition's statement that a person of ordinary skill in the art would understand that reducing effective BWC below 3 g/dL would also achieve g-total BWC ≤ 6 grams for the 200 ml honeycomb of Hiltzik's Example 2. Pet. 83–84. Indeed, the Petition also acknowledges "Clontz SAE's teachings that honeycombs with higher g-total BWC perform better at low purge." Pet. 84 (citing Ex. 1010, 1717; Ex. 1003 ¶ 197).

Clontz WIPO does not support Petitioner's argument that a person of ordinary skill in the art would have been motivated to dilute Hiltzik's honeycomb to reduce its resistance in order to achieve lower emissions. *See*

Pet. 77–78. Clontz WIPO’s description of preparing the honeycomb for its Examples 1–3 (Ex. 1009 ¶¶ 17, 21–22) follows essentially the same method as Hiltzik describes for preparing its Example 2 honeycomb (Ex. 1007, 4:14–32, 5:19–21, 7:26–55) and never compares its honeycomb with Hiltzik’s; both Clontz WIPO and Hiltzik state that their extrusion formulation comprises activated carbon and “the extrusion formulation ingredients partially dilute the carbon adsorbent, and in addition, the adsorbent is further diluted by the open cell structure of the extruded part.” Ex. 1007, 35–47; Ex. 1009 ¶¶ 21–22. Although Clontz WIPO states “[n]onbinding electrical conductivity additives ... may be added for a dual role of adjusting the adsorption properties to flatten the equilibrium isotherm slope, plus obtaining resistivity within the desired range” (Ex. 1009 ¶ 17), context suggests that this statement does not relate to further additives, but rather to “the extrusion formulation ingredients [that] partially dilute the carbon adsorbent” already present in the honeycomb (Ex. 1009 ¶ 22). Thus, we find that a person of ordinary skill in the art would not understand that Clontz WIPO suggests further dilution of Hiltzik, as Petitioner contends,¹⁴ but rather that Clontz WIPO teaches the use of resistive heating of the honeycomb in order to achieve lower emissions.

Clontz WIPO also does not support Petitioner’s argument that a person of ordinary skill in the art would not have understood Clontz SAE (an earlier publication) as suggesting increasing honeycomb working capacity in

¹⁴ Petitioner contradicts this contention in its Reply, by acknowledging that a person of ordinary skill in the art “would not have interpreted Clontz WIPO as suggesting any dilution-based reason for the different test results” for the two honeycombs in Table I. Pet. Reply 8.

low-purge systems. *See* Pet Reply 7. Petitioner’s assertion that “Clontz WIPO does **not** suggest increasing honeycomb working capacity in low-purge systems” (*id.* (citing Ex. 1042 ¶ 37)) at best is based on Clontz WIPO’s silence as to any suggestion of the impact of honeycomb working capacity. Petitioner’s argument that “Clontz WIPO emphasizes the benefits of volumetrically diluting a honeycomb to flatten the isotherm” (*id.* (citing Ex. 1009 ¶ 17)), however, mischaracterizes Clontz WIPO’s disclosure, which contains no such statement.

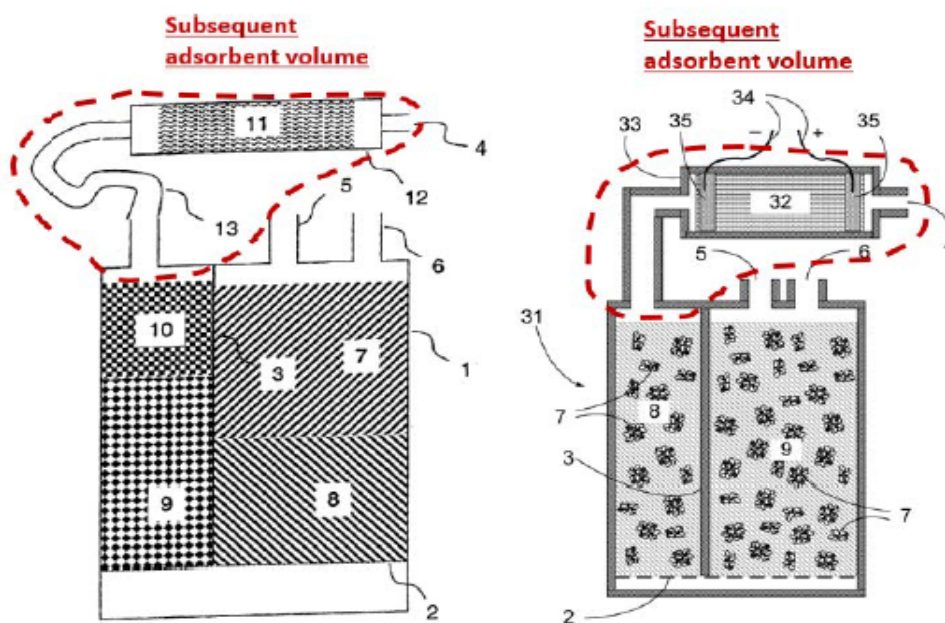
We have also considered Petitioner’s argument that Dr. Rockstraw’s testimony in district court litigation that a person of ordinary skill in the art would understand from Hiltzik “the potential desirability” of reducing BWC below 3g/dL (Ex. 1043, 91:20–92:11; Ex. 1044, 106:2–12) contradicts his opinion here that Hiltzik is silent on the desirability of diluting its Example 2 honeycomb. We agree with Petitioner that this is contradictory evidence, and it weighs against our finding that Hiltzik alone would not suggest reducing its effective BWC below 3g/dL or its g-total BWC below 6g. Petitioner bears the burden of proving invalidity by a preponderance of the evidence, however, and Dr. Rockstraw’s opinion as to Hiltzik’s teachings (which are not in the context of a low-purge system) does not overcome Clontz SAE’s strong suggestion that honeycombs with higher capacity than Hiltzik’s would be desirable for achieving the emissions requirements at low-purge conditions.

Therefore, we find that Petitioner has not established by a preponderance of the evidence that a person of ordinary skill would have been motivated to dilute Hiltzik’s honeycomb adsorbent in order to reduce working capacity of the adsorbent as required by limitations [C] and [D]

while meeting emissions standards at low-purge conditions as required by limitation [F1].

Including a conduit in the “subsequent adsorbent volume”

Petitioner argues that the conduit connecting the main canister and honeycomb adsorbent in both Hiltzik and Clontz WIPO’s systems is an empty space that a person of ordinary skill in the art would consider part of a “subsequent adsorbent volume” along with the honeycomb itself, and would have been motivated to include empty space between the main canister and the honeycomb adsorbent in order to achieve effective BWC below 3g/dL. Pet. 80–81. Petitioner explains its contention by reference to annotated versions of Hiltzik’s Figure 2 and Clontz WIPO’s Figure 3, reproduced below.



Pet. 81. In the annotated version of Hiltzik’s Figure 2, above on the left, Petitioner encircles and labels the parts of Hiltzik’s embodiment, including conduit 13, that purportedly correspond to the “subsequent adsorbent volume”; in the annotated version of Clontz WIPO’s Figure 3, above on the

right, Petitioner encircles corresponding parts of Clontz WIPO. *Id.* For both Hiltzik and Clontz WIPO, Petitioner acknowledges they do not disclose the dimensions of the conduit, but contends a person of ordinary skill in the art would have understood the conduit's volume is significant enough to dilute the honeycomb. *Id.* at 81–82 (citing Ex. 1003 ¶¶ 187–192). Petitioner contends a person of ordinary skill in the art would have been motivated to combine the canister systems of Hiltzik and Clontz WIPO's Examples 2 and 3, to form a cylinder with nominal volume of 66 ml (as taught by Clontz WIPO) using Hiltzik's honeycomb adsorbent which would have an effective BWC less than 3 g/dL (including the conduit), because Examples 2 and 3 achieved 2-day DBL emissions of 20 mg or less at 100 BV of purge or less, and the relatively small size of Clontz WIPO's honeycomb would make it easier to fit into a vehicle's emissions control system. *Id.* at 82 (citing Ex. 1003 ¶¶ 188–194; Ex. 1009, Table II).

Petitioner also relies on Dr. Lyons's analysis of a replacement canister system for certain 2005-2008 Ford models having the main canister connected to the auxiliary canister by a 35 ml conduit. Pet. 81–82 (citing Ex. 1003 ¶¶ 189–91). Dr. Lyons testifies that a conduit of this size when combined with the honeycomb of Hiltzik's Example 2, and the nominal volume of 66 ml as taught by Examples 2 and 3 of Clontz WIPO, would achieve an effective BWC less than 3 g/dL. Ex. 1003 ¶ 191.

Patent Owner argues several reasons why Petitioner fails to show a person of ordinary skill in the art would have been motivated to modify Hiltzik by adding empty space to the “subsequent adsorbent volume” in order to achieve BWC within the claimed range. PO Resp. 30–41. Patent Owner refers to this as “Approach #2.” *Id.* at 14. First, Patent Owner

contends Approach #2 fails because Petitioner incorrectly includes the conduit's volume when computing the effective volume of the adsorbent within the auxiliary canister, which is contrary to the definition of effective volume in the '553 patent. PO Resp. 32–36 (citing Ex. 1001, 6:37–42, 10:25–33, 10:47, 10:63–11:1, 16:32–59, Tables 2–5, Figs. 9, 17; Ex. 2022 ¶¶ 29–45, 251–256). According to Patent Owner, the '553 patent defines an effective volume as starting and ending with an adsorbent bed, and “never includes the conduit's volume when computing or explaining the effective volume, effective BWC, or any effective property of the adsorbent volume within the auxiliary canister.” *Id.* at 36 (citing Ex. 1001, 16:32–20:12, Tables 1–5; Ex. 2022 ¶¶ 29–43, 251–256).

Patent Owner further contends a person of ordinary skill in the art would not have been motivated to use Hiltzik's honeycomb in a cylinder with nominal volume of 66 ml as taught by Examples 2 and 3 of Clontz WIPO, because it would have been contrary to Clontz SAE's teaching to use higher capacity honeycombs at low purge. PO Resp. 36–37 (citing Ex. 1003 ¶ 193; Ex. 1010, 1720; Ex. 2022 ¶ 221). Patent Owner further contends Petitioner has not shown a person of ordinary skill in the art would have been able to form Hiltzik's honeycomb into a 66 ml honeycomb, that the two different honeycombs would be compatible in a canister system, or that Clontz WIPO would have motivated a person of ordinary skill to use a 66 ml volume, because Clontz WIPO does not disclose that the 66 ml volume contributed to lower emissions levels. *Id.* at 37–38 (citing Ex. 1003 ¶ 193; Ex. 1009 ¶ 26; Ex. 2022 ¶¶ 221–222).

In its Reply, Petitioner responds that an “effective volume” in the '553 patent can be defined to begin and end at any two points along the vapor

flow path, and therefore can include a conduit between the main canister and a supplemental canister. Pet. Reply 13 (citing Ex. 1001, 5:4–48, 10:34–35; Ex. 1042 ¶ 58; Ex. 1043, 9:10–10:4). Petitioner argues the “effective volume” calculations relied upon by Patent Owner are non-limiting examples (*id.* at 13–14 (citing Ex. 1001, 10:63–11:8)) and the effective volume calculations in Tables 1–5 of the ’553 patent confirm that the specification does not preclude the calculation of an effective volume as including a conduit. *Id.* at 14 (citing Ex. 1042 ¶ 60).

Petitioner further responds that a person of ordinary skill would have recognized from Clontz WIPO that a 66 ml honeycomb would be a standard and sufficiently effective size, for connection to a main canister via a conduit, to reduce emissions under low-purge conditions. Pet. Reply 14 (citing Ex. 1009, 12, Figs. 2–4; Ex. 1003 ¶ 202). Petitioner argues it would not have been necessary to shrink Hiltzik’s honeycomb from 200 ml to 66 ml because a person of ordinary skill in the art would have recognized Clontz WIPO’s honeycombs were effective in the 66 ml volume, and Petitioner relies on Mr. Williams’s testimony that 66 ml honeycomb was a standard commercial size. *Id.* (citing Ex. 1045, 10:12–12:12).

Discussion

We are not persuaded that a preponderance of the evidence supports Petitioner’s contention that a person of ordinary skill in the art would have been motivated to dilute the Clontz WIPO honeycomb using a conduit. Initially, we note that the Petition stated this challenge as a combination Hiltzik’s Example 2 honeycomb adsorbent in the 66 ml canister of Clontz WIPO’s Examples 2 and 3. Pet. 82. Petitioner contends in its Reply, however, that a person of ordinary skill in the art would not have needed

Hiltzik's teaching as to its honeycomb, but rather would have recognized that Clontz WIPO's smaller 66 ml honeycombs "were sufficiently effective" to reduce emissions under low-purge conditions. Pet. Reply 14 (citing Ex. 1003 ¶ 202). Accordingly, our analysis of this ground is based on the configuration of Clontz WIPO's Examples 2 and 3. Because this issue is dispositive, we need not address the parties' arguments as to the meaning of the term "effective volume."

In discussing the results presented in Table II, Clontz WIPO does not suggest that the volume of the honeycomb contributed to emissions reductions. Ex. 1009 ¶¶ 25–26. Rather, it compares the data obtained in Example 2 "without electrical current passing through the honeycomb" at 100 v/v purge, to the reduction in emissions obtained "by application of a modest electrical current through the honeycomb during the 100 v/v purge." *Id.* ¶ 25. In Example 3, it states

Extremely low emissions of 4 mg are obtained at 75 v/v purge by an increased heating wattage to the honeycomb and by having formed a circumferential notch 8 mm deep into the skin of the honeycomb....

Id. ¶ 26. Thus, the relevant features of Example 2 that Clontz WIPO discusses as contributing to low emissions relate to the application of electrical current, and notably, Clontz WIPO's basis for comparison of Example 3 to Example 2 is increased heating wattage and a circumferential notch in the honeycomb. Both examples use the same 66 ml honeycomb to obtain all of the results in Table II, so there is no reason a person of ordinary skill in the art would have understood from Clontz WIPO whether or how honeycomb volume contributed to the results.

In light of Clontz WIPO's teachings, we are not persuaded by Petitioner's contention that "a person of ordinary skill in the art would have been motivated to use the smaller honeycomb of Clontz WIPO because that honeycomb achieved the best low-purge emissions of any other example in Clontz WIPO or Clontz SAE." *See* Pet. 84 (citing Ex. 1009, Table II). It does not make sense that a person of ordinary skill in the art would have expected Clontz WIPO's 66 ml honeycomb size to contribute to low emissions levels, where Clontz WIPO provides no disclosure relating to adsorbent characteristics of the honeycomb such as BWC, and distinguishes its results based on other features.

Further, as discussed above, Clontz SAE taught that for low-purge systems, higher working capacity honeycombs, as compared to Hiltzik's, were necessary. For the same reasons, Clontz SAE's teaching also does not support Petitioner's contention that a person of ordinary skill in the art would have been motivated to use Clontz WIPO's 66 ml honeycomb with a conduit in order to achieve low emissions.

We have also considered Petitioner's argument that the 66 ml honeycomb disclosed in Clontz WIPO was a commercially available, standard-size honeycomb. Pet. Reply 14 (citing Ex. 1045, 10:12–12:12). Although this evidence is a factor that could support a person of ordinary skill's choice of that honeycomb when designing a canister system to achieve low emissions, feasibility alone does not support a motivation to combine. Demonstrating a reason to combine teachings in the prior art requires showing that a modification would have been desirable, not merely possible. *Belden Inc. v. Berk-Tek LLC*, 805 F.3d 1064, 1073 (Fed. Cir. 2015) ("[O]bviousness concerns whether a skilled artisan not only could

have made but would have been motivated to make the combinations or modifications of prior art to arrive at the claimed invention.”). For the reasons discussed above, we determine that Petitioner has not demonstrated by a preponderance of the evidence that claim 1 would have been obvious.

Independent Claims 21, 51, 55, and 64

Patent Owner provides a table summarizing the recitation of relevant limitations of the challenged independent claims, reproduced below:

Limitation	Cl. 1	Cl. 21	Cl. 51	Cl. 55	Cl. 64
[B]: eIAC < 35 g/L	✓	✓	✓	✓	✓
[C]: eBWC < 3 g/dL	✓		✓		✓
[D]: g-total BWC ≤ 6 g	✓	✓		✓	✓
[F1]: 2D DBL emissions ≤ 20 mg at ≤ 100 BV of purge	✓			✓	
[F2]: 2D DBL emissions ≤ 20 mg at ≤ 210 L of purge		✓			
[F3]: 2D DBL emissions ≤ 20 mg at ≤ 100 BV or 210 L of purge			✓		

PO Resp. 8. The figure reproduced above is a table including a column for each independent claim 1, 21, 51, 55, and 64, and a row for each claim limitation [B], [C], [D], [F1], [F2], and [F3].

Patent Owner contends that because each of the challenged claims recite at least one of limitations [C] and [D], Petitioner can only prevail in establishing obviousness if it proves a person of ordinary skill would have been motivated to modify or combine Hiltzik, Clontz SAE, and Clontz WIPO according to Approach #1 or #2. PO Resp. 14. Petitioner does not

dispute this. *See* Pet. Reply. Therefore, because we find as discussed above that Petitioner has not made this showing by a preponderance of the evidence, we also find Petitioner has not demonstrated that claims 21, 51, 55, and 64 would have been obvious over the combination of Hiltzik, Clontz SAE, and Clontz WIPO.

Dependent Claims

Claims 6–10, 14–20, 22–28, 32–38, 52, 56, 57, 59, 65–72, and 76–82 each depend from claim 1, 21, 51, 55, or 64. Petitioner’s arguments with respect to these dependent claims do not address the deficiency discussed above with respect to claim 1. Thus Petitioner has not demonstrated by a preponderance of the evidence that these dependent claims would have been obvious over the combination of Hiltzik, Clontz SAE, and Clontz WIPO.

III. MOTIONS TO EXCLUDE

A. Petitioner’s Motion to Exclude

Petitioner filed a motion to exclude Exhibit 2080 and paragraph 39 of Exhibit 2027. Paper 57 (“Pet. Mot.”). We do not discuss or cite Exhibit 2080 or paragraph 39 of Exhibit 2027 in this Decision, and consideration of them played no part in our determinations set forth herein. Because their presence in the record would not affect our analysis in this Decision, we dismiss as moot Petitioner’s motion with respect to these exhibits.

B. Patent Owner’s Motion to Exclude

Patent Owner filed a motion to exclude Exhibits 1015–1016, 1023–1025, 1032, 1038–1039, 1042 (certain paragraphs), 1044, 1046–1049, and

1052–1054. Paper 56 (“PO Mot.”). Patent Owner groups these exhibits into four categories, which we apply in discussing the motion below.

1. Patent Owner moves to exclude Exhibits 1015 and 1046 as “irrelevant determinations from other adjudicative bodies regarding different patents.” PO Mot. 1. We do not discuss or cite these exhibits in this Decision, and have not considered them in reaching our decision herein. Because the presence of these exhibits in the record would not affect our analysis in this Decision, we dismiss as moot Patent Owner’s motion with respect to these exhibits.

2. Patent Owner moves to exclude Exhibits 1023, 1024, 1025, 1032, 1046, 1047, an alleged Ford replacement canister, and an eBay listing for another canister in Exhibit 1042 ¶ 63, under FRE 402 on the basis that Petitioner “attempt[s] to have the Board consider many exhibits outside of the Ground to make substantive obviousness arguments to cure the defects in the combination of the three references it chose.” PO Mot. 4 (citing *Genzyme Therapeutic Prod. Ltd. P’ship v. Biomarin Pharm. Inc.*, 825 F.3d 1360, 1369 (Fed. Cir. 2016)). We do not discuss or cite these exhibits or paragraphs in this Decision, except for Exhibits 1023 and 1024 (referred to as Gadkaree and Park, respectively *supra*), which we cite in discussing the parties’ arguments. We do not discuss Exhibits 1023 and 1024 as a basis for this Decision, however, because we determine patentability based on the three references that Petitioner identified as the basis for its § 103 challenge. Therefore, because the presence of all of these exhibits in the record would not affect our analysis in this Decision, we dismiss as moot Patent Owner’s motion with respect to these exhibits

3. Patent Owner moves to exclude Exhibits 1016, 1038, 1039, and 1052–1054, in addition to certain paragraphs of Exhibit 1042, because none of Petitioner’s papers discuss or cite these exhibits or paragraphs. PO Mot. 6. We do not discuss or cite these exhibits or paragraphs in this Decision, and they do not form any basis for our decision herein. Because the presence of these exhibits in the record would not affect our analysis in this Decision, we dismiss as moot Patent Owner’s motion with respect to these exhibits.

4. Patent Owner moves to exclude Exhibits 1048 and 1049 as having been untimely produced by Petitioner and unauthenticated under FRE 901. We do not discuss or cite these exhibits in this Decision, and they do not form any basis for our decision herein. Because the presence of these exhibits in the record would not affect our analysis in this Decision, we dismiss as moot Patent Owner’s motion with respect to these exhibits.

IV. SUMMARY

For the reasons discussed above, Petitioner has not demonstrated by a preponderance of the evidence that claims 1–10, 14–28, 32–38, 51, 52, 55–57, 59, 64–72, and 76–82 of the ’553 patent are unpatentable. Our conclusions regarding the challenged claims are summarized below:

Claims	35 U.S.C. §	Reference(s) /Basis	Claims Shown Unpatentable	Claims Not Shown Unpatentable
1–10, 14–28, 32–38, 51, 52, 55–57, 59, 64–72, and 76–82	112(b)	Indefiniteness		1–10, 14–28, 32–38, 51, 52, 55–57, 59, 64–72, and 76–82
1–10, 14–28, 32–38, 51, 52, 55–57, 59, 64–72, and 76–82	103(a)	Hiltzik, Clontz WIPO, and Clontz SAE		1–10, 14–28, 32–38, 51, 52, 55–57, 59, 64–72, and 76–82
Overall Outcome				1–10, 14–28, 32–38, 51, 52, 55–57, 59, 64–72, and 76–82

Additionally, we dismiss as moot Petitioner’s Motion to Exclude and Patent Owner’s Motion to Exclude.

V. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that Petitioner has not shown claims 1–10, 14–28, 32–38, 51, 52, 55–57, 59, 64–72, and 76–82 of the ’553 patent are unpatentable by a preponderance of the evidence;

FURTHER ORDERED that Petitioner’s Motion to Exclude is dismissed as moot;

FURTHER ORDERED that Patent Owner’s Motion to Exclude is dismissed as moot; and

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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