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Paper 30
Entered: January 15, 2021

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

REMEDIATION PRODUCTS, INC.,
Petitioner,

v.

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.,
Patent Owner.

IPR2019-01452
Patent 7,531,709 C1

Before CHRISTOPHER M. KAISER, JEFFREY W. ABRAHAM, and DAVID COTTA, *Administrative Patent Judges.*

KAISER, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining All Claims Unpatentable
35 U.S.C. § 318(a)

INTRODUCTION

A. Background

Remediation Products, Inc. ("Petitioner") filed a Petition (Paper 3, "Pet.") requesting an *inter partes* review of claims 1–18 of U.S. Patent No. 7,531,709 C1 (Ex. 1001, "the '709 patent"). Innovative Environmental Technologies, Inc. ("Patent Owner") did not file a Preliminary Response. We instituted review of all challenged claims on each of the grounds asserted in the Petition. Paper 11 ("Dec. Inst.").

Following institution, Patent Owner filed a Response (Paper 15, "PO Resp."), Petitioner filed a Reply (Paper 20, "Reply"), and Patent Owner filed a Sur-Reply (Paper 22, "PO Sur-Reply"). Petitioner also filed a motion to strike portions of the Sur-Reply and certain exhibits. Paper 24 ("Mot."). Patent Owner opposed this motion. Paper 27 ("Opp. Mot."). We held a hearing on November 13, 2020, the transcript of which has been entered into the record. Paper 29 ("Tr.").

We have jurisdiction under 35 U.S.C. § 6, and we issue this Final Written Decision pursuant to 35 U.S.C. § 318(a). We conclude that Petitioner has established by a preponderance of the evidence that claims 1–18 of the '709 patent are unpatentable.

B. Related Matters

The parties identify *Innovative Environmental Technologies, Inc. and Provectus Environmental Products, Inc. v. Total Petrochemicals & Refining USA, Inc. and Retia USA, LLC*, Case No. 2:18-cv-03211-GJP (E.D. Pa.), now dismissed without prejudice, as a case related to this one. Pet. 3; Paper 5, 2; Paper 10, 2.

C. The Asserted Grounds of Unpatentability

Petitioner contends that claims 1–18 of the '709 patent are unpatentable based on the following grounds (Pet. 19–74):[1]

35 U.S.C. §	Reference(s)/Basis	Claim(s) Challenged
§ 102(b)[2]	Orolin[3]	1–3, 6–8, 14, 17, 18
§ 102(a)	Vance[4]	1, 3, 9, 14–18
§ 102(b)	Hamilton Beach[5]	1, 3, 9, 14, 17, 18
§ 103(a)	Orolin, Liskowitz,[6] Vance	1–4, 6–8, 10, 13, 14, 17, 18
§ 103(a)	Orolin, Vance	3, 9, 15, 16
§ 103(a)	Orolin, Rice,[7] Vance	5, 11, 12
§ 103(a)	Hamilton Beach, Permit Application[8]	1, 3, 9, 14, 17, 18

[1] Petitioner also relies on a Declaration from John Thomas Wilson, Ph.D. Ex. 1004.

[2] The Leahy-Smith America Invents Act ("AIA"), Pub. L. No. 112-29, 125 Stat. 284, 287–88 (2011), amended 35 U.S.C. §§ 102 and 103, effective March 16, 2013. Because the application from which the '709 patent issued was filed before this date, the pre-AIA versions of §§ 102 and 103 apply.

[3] Orolin et al., US 5,766,929, issued June 16, 1998 (Ex. 1005, "Orolin").

[4] Vance et al., US 2002/0151602 A1, published Oct. 17, 2002 (Ex. 1006, "Vance").

[5] NESCO Inc., Remediation Technologies Group, Bench Study to Evaluate the Use of Zero-Valent Iron for Remediation of Solvent Contamination at the Hamilton Beach-Proctor Silex Site in Washington, North Carolina (May 8, 2001) (Ex. 1010, "Hamilton Beach").

[6] Liskowitz et al., US 5,975,798, issued Nov. 2, 1999 (Ex. 1008, "Liskowitz").

[7] Rice et al., US 6,001,252, issued Dec. 14, 1999 (Ex. 1009, "Rice").

[8] North Carolina Department of Environment and Natural Resources, Application for Permit to Construct and/or Use a Well(s) for Injection (July 30, 1999) (Ex. 1011, "Permit Application").

35 U.S.C. §	Reference(s)/Basis	Claim(s) Challenged
§ 103(a)	Hamilton Beach, Rice	2, 5, 12
§ 103(a)	Hamilton Beach, Liskowitz	4, 10, 13

D. The '709 Patent

The '709 patent, titled "Method for Accelerated Dechlorination of Matter," originally issued on May 12, 2009. Ex. 1001, codes (45), (54). A Reexamination Certificate issued on July 16, 2018. *Id.*, Reexamination Certificate, code (45). The '709 patent "relates to an accelerated dechlorination of subsurface matter by anaerobic microorganisms in conjunction with oxygen scavengers, vitamins, nutrients, and zero valent metals." *Id.* at 1:18–21. According to the patent, "chlorinated solvents have had a large impact on several industries," but, "[w]ith wide spread use and improper handling and storage, extensive soil and water damage has occurred." *Id.* at 1:25–29. The patent describes "a need in the art to utilize the ability of anaerobic microorganisms to decompose chlorinated compounds . . . at a faster rate" than can be achieved using prior-art methods. *Id.* at 1:53–2:7. This is achieved "by stimulating anaerobic microorganisms and thus increasing the rate of biological mineralization of the solvents." *Id.* at 2:11–14. Specifically, the '709 patent describes "a treatment process consisting of a colloidal suspension of metal powder, organic hydrogen donor . . . , chemical oxygen scavengers . . . , and vitamin stimulants . . . delivered via interconnected pneumatic pumps and pressurized vessels . . . ." *Id.* at 2:14–22.

E. Illustrative Claim

Claims 1–18 of the '709 patent are challenged. Claim 1 is independent and illustrative; it recites:

> 1. A method for accelerated anaerobic dechlorination of subsoil, comprising the steps of:
>
> supplying a mixture including a zero valent metal into permeable pathways in the subsoil that chlorinated solvents have migrated to in order to reduce concentrations of dissolved chlorinated solvents in groundwater via chemical reactions with a surface of the zero valent metal providing a hydrogen source via hydrolysis of the groundwater at the surface of the zero valent metal and evolution of the hydroxides; and
>
> supplying an organic hydrogen donor into the permeable pathways to provide a hydrogen source via the fermentation of the organic hydrogen donor and produce dechlorinating conditions such that indigenous anaerobic bacteria biodegrade residual concentrations of chlorinated solvents, wherein combined use of the zero valent metal and the organic hydrogen donor together in the permeable pathways accelerate dechlorination of contaminants in the subsoil and dechlorinate intermediates of the chlorinated solvents.

Ex. 1001, Reexamination Certificate, 2:2–22.

ANALYSIS

A. Claim Construction

In an *inter partes* review, we construe claim terms in an unexpired patent "in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent," as the claims would be construed "in a civil action under 35 U.S.C. 282(b)." 37 C.F.R. § 42.100(b) (2019). Only terms that are in controversy need to be construed, and then only to the extent necessary to resolve the controversy. *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999). Petitioner proposes construing two

claim terms: "a mixture including a zero valent metal" and "dechlorinate" or "dechlorination," Pet. 11–14, and we address each term below.

1. The "Dechlorination" Terms

The challenged claims use the terms "dechlorination," "dechlorinate," and "dechlorinating conditions." Ex. 1001, Reexamination Certificate, 2:2–22. Petitioner argues that we should interpret these terms to refer to the "removal of one or more chlorine atoms from contaminants or intermediates." Pet. 13–14; Reply 3–5. Patent Owner argues that we should construe these terms instead to refer to the "removal of one or more chlorine atoms from contaminants or intermediates at a contaminated site in an attempt to reduce contaminants or intermediates at the contaminated site to an acceptable level." PO Resp. 11–13; Sur-Reply 6–13.

During the hearing, both parties abandoned these proposed constructions in favor of using the language of the challenged claims themselves to define the scope of "dechlorinate." Tr. 36:7–9 (Patent Owner's counsel stating that "the claim language defines what dechlorinate means," so "it really didn't need to be construed"), 44:21–24 (Patent Owner's counsel stating that the claim "provides the context that's needed" to construe the dechlorination terms), 63:18–64:10 (Petitioner's counsel stating that the dechlorination terms need not be construed, as long as they do not impose "a minimal threshold of dechlorination"). Specifically, claim 1 defines "dechlorinating conditions" as those conditions that permit "indigenous anaerobic bacteria [to] biodegrade residual concentrations of chlorinated solvents." Ex. 1001, Reexamination Certificate, 2:2–22. Based on the plain language of the claims and per the parties' positions, we adopt this as the construction of "dechlorinating conditions," and we interpret

"dechlorinate" or "dechlorination" to mean "the biodegradation of residual concentrations of chlorinated solvents by indigenous anaerobic bacteria."

2. "A Mixture Including a Zero Valent Metal"

Petitioner contends that "a mixture including a zero valent metal" should be construed to mean "a combination of a zero valent metal with at least one additional component other than the organic hydrogen donor." Pet. 12–13. Patent Owner argues that we need not construe this term and does not offer a proposed construction. PO Resp. 11. We agree that we do not need to construe this term in order to resolve the patentability of the challenged claims.

B. Obviousness Grounds Based on Orolin

Petitioner argues that claims 1–18 of the '709 patent would have been obvious given the teachings of Orolin with, in various combinations, the teachings of Vance, Liskowitz, and Rice. Pet. 54–67.

1. Orolin

Orolin discloses a "bioremediation method and compositions for promoting activity in indigenous microorganisms, causing the micro-organisms to degrade organic contaminants." Ex. 1005, code (57). The method of Orolin can be used "to degrade halogenated contaminants" "in contaminated soil and groundwater," with the halogenated contaminants including "tetrachloroethylene," "trichloroethene," "trichloroethane," and "1,2dichlorobenzene." *Id.* at 1:66–2:9. The microorganisms that Orolin's method promotes may be "anaerobic, aerobic and facultative." *Id.* The disclosed method involves injecting a "bioremediation composition[] . . . under pressure into the sub-surface environment." *Id.* at 9:32–34. "Included in the bioremediation compositions . . . will be the iron derivatives, the

sulfate salts, the electron donors, the yeast extracts, the glacial tills, the nitrogen compounds and the phosphorus compounds." *Id.* at 9:37–41. Orolin teaches that the "iron derivative" used may be "elemental iron." *Id.* at 4:42–47. Orolin's "preferred electron donor . . . is typically sodium benzoate." *Id.* at 5:39–40. The "yeast extracts" used in Orolin's compositions can include "riboflavin B2" and "vitamin B12," among many other compounds. *Id.* at 5:51–58.

2. Vance

Vance relates to "the sequential reduction of chlorinated hydrocarbons to innocuous end products such as methane, ethane or ethene" as a means of accomplishing "the in-situ treatment of chlorinated solvents." Ex. 1006 ¶ 2. Vance's "process exploits the use of zero valence state elemental metals to reductively dehalogenate halogenated hydrocarbons." *Id.* Specifically, Vance teaches that the elemental metal preferably is "selected from the group of iron, tin, zinc and palladium," with "[t]he most preferred [being] iron." *Id.* ¶ 112. Vance discloses "a method of injecting nanoscale metal particles into soil" in which the first step is "making a colloid suspension having metal particles in the presence of a carbohydrate" and the second step is "injecting said colloid suspension into the soil through a well at a flow rate sufficient to move the colloid suspension through the soil." *Id.* ¶¶ 118–120. "The nanoscale metal particles may be injected by any known method." *Id.* ¶ 121. The carbohydrate solution may be "[a]ny carbohydrate solution that creates an oxygen-scavenging environment," but "corn syrup" is "[m]ost preferabl[e]." *Id.* ¶ 122.

3. Liskowitz

Liskowitz relates to "[a] method for the in-situ remediation of contaminants including . . . halogenated hydrocarbons that are present in groundwater, absorbed [sic] to soil, and exist in the free product state in a soil volume." Ex. 1008, code (57). Specifically, Liskowitz teaches "inject[ing] pre-determined quantities of reactive zero valent iron powder relative to the quantity of contaminants present in the soil." *Id.* "A well . . . was drilled into soil containing industrial wastes, the well was capped, and pressurized fluids [were] introduced into the well . . . for creating a series of channels . . . radiating from the well." *Id.* at 8:52–57. Either after creation of these channels or simultaneously with their formation, "a mixture of gases and a liquid solution containing the iron powder is injected into the channels, thus enplacing the powder therein." *Id.* at 8:57–60.

4. Rice

Rice relates to "[a] method for in situ anaerobic dehalogenation of a halogenated organic compound in a groundwater plume." Ex. 1009, code (57). Rice's method "reduces or prevents indigenous aerobic microorganisms from competing for a supplied electron donor with an anaerobic microorganism that reductively dehalogenates the organic compound when an electron donor is available." *Id.* Rice teaches injecting an aqueous solution of an electron donor into the treatment zone. *Id.* at 3:39–46, 3:58–4:6. Rice also teaches that "[t]he water of the aqueous solution can be deoxygenated groundwater or can be water that is physically or chemically deoxygenated, for example, . . . by adding a strong reducing agent, such as, but not limited to, sulfite or citrate." *Id.* at 3:47–51.

"Sodium sulfite at approximately 8 to 12 mg/L per mg/L dissolved oxygen is suitable." *Id.* at 3:51–53.

5. Analysis

Petitioner argues that various combinations of Orolin, Vance, Liskowitz, and Rice teach or suggest the subject matter of claims 1–18 of the '709 patent. Pet. 54–67. Petitioner also argues that a person of ordinary skill in the art would have had a reason to combine the teachings of these references. *Id.*

a. Claim 1

Petitioner argues that claim 1 would have been obvious over the combination of Orolin, Liskowitz, and Vance. Pet. 54–58.

(1) Preamble

The preamble of claim 1 recites "[a] method for accelerated anaerobic dechlorination of subsoil." Ex. 1001, Reexamination Certificate, 2:2–3. Orolin discloses a "bioremediation method" that can be used "to degrade halogenated contaminants" "in contaminated soil and groundwater," with the halogenated contaminants including "tetrachloroethylene," "trichloroethene," "trichloroethane," and "1,2dichlorobenzene." Ex. 1005, code (57), 1:66–2:9. Orolin's method may facilitate bioremediation "far below the surface of the earth." *Id.* at 9:54–59. Thus, Orolin teaches or suggests the preamble of claim 1.[9] Patent Owner does not contest that Orolin discloses the preamble of claim 1.

[9] Because Petitioner has shown that Orolin discloses the recitation in the preamble, we need not determine whether the preamble is limiting.

(2) "Supplying a mixture including a zero valent metal into permeable pathways in the subsoil that chlorinated solvents have migrated to"

Claim 1 also recites "supplying a mixture including a zero valent metal into permeable pathways in the subsoil that chlorinated solvents have migrated to." Ex. 1001, Reexamination Certificate, 2:4–6. Petitioner argues that Orolin teaches or suggests this limitation. Pet. 22. Patent Owner argues that Orolin's bioremediation composition "does not contain [zero-valent iron] by the time that it is applied to the contaminated site." Sur-Reply 17–19.

Orolin's bioremediation composition includes an iron derivative. Ex. 1005, code (57). Orolin discloses that the "iron derivative" may be "electrolytic iron" or "elemental iron," in addition to various compounds of iron, such as "ferric citrate" or "ferrous sulfate." *Id.* at 4:42–47. Dr. Wilson testifies that both "electrolytic iron" and "elemental iron" refer to zero-valent iron. Ex. 1004 ¶ 204.

Orolin teaches that, when the contaminants are located below the surface, its bioremediation composition "in solution [is] injected into the sub-surface environment" "so as to allow the indigenous micro-organisms to degrade the contaminants." Ex. 1005, 9:30–59. Patent Owner argues that, although Orolin permits the use of zero-valent iron in some embodiments, the requirement in the injection embodiment that the composition be "in solution" means that the iron derivatives used in the injection embodiment cannot be zero-valent iron, because zero-valent iron does not dissolve in water. Sur-Reply 17–19. We do not find this argument persuasive.

Patent Owner is correct that Orolin uses the phrase "in solution" to describe the injected bioremediation composition. Ex. 1005, 9:30–41. In

addition, in an embodiment using zero-valent iron, Orolin describes its composition as "thoroughly dissolved," and it describes its "preferred form" of bioremediation composition as "dissolved in . . . water." *Id.* at 3:33–39, 15:35–62. And Dr. Wilson testifies that zero-valent iron cannot be dissolved in water. Ex. 2025, 25:21–25 ("ZVI is not soluble in water.").

Dr. Wilson, however, explained that there was a distinction between how a chemist would use the terms "dissolved," "soluble," and "in solution" and how Orolin uses those terms. *Id.* at 24:11–25:4 (distinguishing between "the legal word 'dissolved'" and "the scientific chemical word 'dissolved'"), 25:21–26:11 (testifying that zero-valent iron cannot be dissolved in water "in the formal sense [in which] the chemist would use [the word]"). When pressed on the meaning of Orolin's use of the phrase "in solution," Dr. Wilson stated that Orolin did not use the term in the formal chemical sense, but rather in the sense of "taken up into the body of water so that it can be effectively applied as a fluid." *Id.* at 24:11–25:4. Dr. Wilson explained that,

> since Orolin is introducing material that cannot be disassociated to the level of atoms or molecules in the fluid, he must be meaning dissolved in the more general layman's sense of simply carried up and – sustained in the fluid as it's injected. A chemist would use the word . . . "[s]uspended."

Id. at 24:23–25:4. Dr. Wilson also testified that Orolin's use of the term "thoroughly dissolved" was inconsistent with the narrow, technical meaning of "dissolved," because, under that narrow meaning, there either is or is not dissolution, and thus Orolin's use of the word "thoroughly" as a modifier for something that is "dissolved" in the chemical sense would make no sense. Ex. 2025, 26:12–27:24; *see* Ex. 1005, 15:63–64 ("The mixture was thoroughly dissolved . . ."). Thus, the mere fact that Orolin uses a term that is capable of being given a narrow, technical meaning does not mean that a

person of ordinary skill in the art would have understood Orolin as actually using the term in that narrow, technical sense.

We credit Dr. Wilson's testimony and find that his explanation of Orolin's use of the term "dissolved" is persuasive of how a person of ordinary skill in the art would understand that term. We have not been directed to persuasive evidence of record contradicting Dr. Wilson's interpretation of how a person of ordinary skill in the art would interpret Orolin. Patent Owner directs us only to Orolin's use of "in solution" and Dr. Wilson's deposition testimony to support its argument that Orolin uses "in solution" or "dissolved" purely in the limited, formal, chemical sense. Sur-Reply 17–19 (citing Ex. 1005, 3:33–39, 9:25–36, 11:17–19, 15:63–64; Ex. 2025, 24:11–25:4, 26:5–27:24). As discussed above, however, once we consider Orolin's use of the terms "dissolved" and "in solution" in the context of Orolin's full disclosure, we find that Orolin supports a broader interpretation of those terms, and Dr. Wilson explained persuasively why a person of ordinary skill in the art would have understood that a limited, formal, chemical definition was not applicable in the context of Orolin.

The evidence in the record, both the text of Orolin itself and the testimony of Dr. Wilson, suggests that the use of the terms "dissolved" and "in solution" in Orolin comports with Petitioner's broader interpretation encompassing the suspension of zero-valent iron particles in a bulk water phase so that it can be effectively applied as a fluid. Because Orolin teaches the use of zero-valent iron in its bioremediation compositions, and because it teaches delivering those compositions "into the sub-surface environment," Orolin teaches or suggests this limitation.

> *(3) "In order to reduce concentrations of dissolved chlorinated solvents in groundwater via chemical reactions with a surface of the zero valent metal providing a hydrogen source via hydrolysis of the groundwater at the surface of the zero valent metal and evolution of hydroxides"*

Claim 1 next recites "in order to reduce concentrations of dissolved chlorinated solvents in groundwater via chemical reactions with a surface of the zero valent metal providing a hydrogen source via hydrolysis of the groundwater at the surface of the zero valent metal and evolution of hydroxides." Ex. 1001, Reexamination Certificate, 2:6–12.

Petitioner argues that Orolin's delivery of zero-valent iron to locations in the subsoil with chlorinated contaminants present inherently would result in reducing the concentration of those contaminants via chemical reactions with the surface of the iron particles, providing a hydrogen source via hydrolysis of the groundwater at the surface of the iron and evolution of hydroxides. Pet. 23–24. Dr. Wilson testifies in support of this inherency argument, and he provides support for his opinions. Ex. 1004 ¶¶ 210–214 (citing Ex. 1018, 2, Fig. 2-3; Ex. 1027, Fig. 8).

Patent Owner disagrees with Petitioner's argument that a person of ordinary skill in the art would have understood Orolin as teaching the delivery of zero-valent iron for the purpose of generating hydrogen by hydrolysis of the groundwater on the surface of the metal. PO Resp. 24–26. Specifically, Patent Owner argues that Orolin teaches using only a small amount of iron that would be sufficient to act as a nutrient for bacteria but insufficient to participate in the hydrogen-generating reactions of claim 1. *Id.* at 25.

We are not persuaded by Patent Owner's argument. The argument rests on the teaching in Orolin that the zero-valent iron "must be added in sufficient quantity . . . to achieve a concentration at the contaminated site of from about 30 to about 100 parts per million by weight." Ex. 1005, 4:32–36. Patent Owner's declarant, Dr. John S. Haselow, testifies that this concentration is insufficient to permit the iron to participate in the recited hydrogen-generating reactions. Ex. 2002 ¶¶ 124, 185. But Dr. Haselow does not cite any support for this testimony. Instead, he states that a person of ordinary skill in the art "would understand that at such low concentrations . . . the iron derivatives would be[] used as nutrients and not for chemical reduction." *Id.* ¶ 124. He also testifies that a person of ordinary skill in the art "would understand that the amount of iron derivative utilized in Orolin is sufficient to act as a nutrient but is not sufficient to create the chemical reactions required by claim 1." *Id.* ¶ 185. "Expert testimony that does not disclose the underlying facts or data on which the opinion is based is entitled to little or no weight." 37 C.F.R. § 42.65(a). Thus, we give little weight to Dr. Haselow's conclusory testimony that zero-valent iron present in the low concentrations taught by Orolin would be insufficient to create the hydrogen-generating reactions of claim 1.

Patent Owner's argument also relies on the assumption that a person of ordinary skill in the art who was motivated to combine the teachings of Orolin, Vance, and Liskowitz would adhere closely to Orolin's recommendations for zero-valent iron concentration. But Orolin teaches that "[d]iffering environmental factors at each contaminated site determine the amount of the iron derivatives to be added to the bioremediation compositions." Ex. 1005, 4:30–32. This suggests that a person of ordinary

skill in the art would know how to determine an appropriate amount of zero-valent iron to use to achieve Orolin's bioremediation results.

Similarly, Vance teaches that "zero valence state elemental metals," including iron, may be used "to reductively dehalogenate halogenated hydrocarbons." Ex. 1006 ¶¶ 2–7. It also teaches that the iron "may act as a catalyst for the reaction of hydrogen with the halogenated hydrocarbon," with the hydrogen being "produced on the surface of the iron metal as the result of corrosion with water." *Id.* ¶ 6. Thus, Vance teaches both delivering zero-valent iron and doing so for the same purpose as recited in claim 1. *See* Tr. 38:2–17. But Vance does not teach using any particular concentration of zero-valent iron to achieve this result, suggesting that a person of ordinary skill in the art would know how to determine the proper concentration of zero-valent iron to accomplish the abiotic reduction of chlorinated contaminants. Similarly, Liskowitz teaches injecting zero-valent iron powder into "subsurface sources of contamination" and that injecting iron causes a reaction with groundwater that produces hydrogen. Ex. 1008, 2:59–3:14. Liskowitz also teaches that "[t]he minimal quantity of zero valent iron powder required to remediate . . . halogenated hydrocarbons in a specified time period is determined on a site-by-site basis." *Id.* at 7:26–29.

Thus, a person of ordinary skill in the art would have known how to determine how much zero-valent iron to use to accomplish either the abiotic reduction of chlorinated contaminants or the bioremediation of chlorinated contaminants. Given this, we find that a person of ordinary skill in the art would know how to determine the proper iron concentration to permit both processes to proceed. *See also* Ex. 1036, 46:8–47:4 (Dr. Haselow testifying that, over a contaminated site, zero-valent iron would act as both a bacterial

nutrient and an abiotic reductant); Ex. 1037 ¶ 39 (Dr. Wilson agreeing with Dr. Haselow).

Petitioner relies on a combination of teachings from Orolin, Vance, and Liskowitz to teach or suggest this limitation. "An invention is not obvious just 'because all of the elements that comprise the invention were known in the prior art.'" *Broadcom Corp. v. Emulex Corp.*, 732 F.3d 1325, 1335 (Fed. Cir. 2013) (quoting *Power-One, Inc. v. Artesyn Techs., Inc.*, 599 F.3d 1343, 1351 (Fed. Cir. 2010)). Instead, Petitioner must show that a person of ordinary skill in the art would have had a reason to combine those teachings. Here, Petitioner argues that a person of ordinary skill in the art would have had a reason to combine the teachings of Orolin, Vance, and Liskowitz. Pet. 55–57. Patent Owner does not contest the reason to combine the teachings of these references. PO Resp. 46.

We find that Petitioner has shown a reason to combine by a preponderance of the evidence. Dr. Wilson testifies that a person of ordinary skill in the art would have known that Orolin's composition would have been difficult to deliver to certain geological formations with limited permeability. Ex. 1004 ¶ 305. Liskowitz teaches a way of overcoming this limitation in "tight geological formations." Ex. 1008, 8:30–51. Orolin teaches using zero-valent iron to dechlorinate contaminants, and Vance teaches that a colloidal suspension of zero-valent iron in corn syrup has several advantages, including accelerating the dechlorination process and lower expenses. Ex. 1006 ¶¶ 9–12, 122. Thus, a person of ordinary skill in the art would have had reason to combine the teachings of Liskowitz and Vance with those of Orolin, and this combination of references teaches or suggests this limitation.

(4) "Supplying an organic hydrogen donor into the permeable pathways to provide a hydrogen source via the fermentation of the organic hydrogen donor"

Claim 1 recites "supplying an organic hydrogen donor into the permeable pathways to provide a hydrogen source via the fermentation of the organic hydrogen donor." Ex. 1001, Reexamination Certificate, 2:13–15. The '709 patent uses the terms "hydrogen donor" and "electron donor" interchangeably. *Id.* at 4:28–29 ("an electron donor source to provide hydrogen"), 4:29–36 (exemplifying "an electron donor" by naming several "organic hydrogen donor[s]"). Orolin's injected composition includes "electron donors." Ex. 1005, 9:37–41. Orolin's "preferred electron donor . . . is typically sodium benzoate." *Id.* at 5:39–40. Dr. Wilson testifies that, when sodium benzoate is supplied to the soil for bioremediation, it will ferment to produce hydrogen. Ex. 1004 ¶¶ 216–218.

Patent Owner argues that Orolin's sodium benzoate would be ineffective at promoting bioremediation because it "is a preservative that could limit the activity of the bacteria and could be toxic to the bacteria." PO Resp. 27 (citing Ex. 2002 ¶¶ 130, 131, 189, 190; Ex. 2003, 166:14–167:22; Exs. 2011–2013). This argument contradicts the express text of Orolin, which says that its electron donors must "allow the indigenous bacteria to properly degrade the contaminants." Ex. 1005, 5:40–43. Moreover, Orolin's disclosure is not limited to sodium benzoate, which it calls its "preferred electron donor." *Id.* at 5:39–40. Instead, Orolin teaches that any suitable electron donor may be used. *Id.* at 5:40–43. Thus, Orolin teaches or suggests this limitation.

In addition, even if we were persuaded that Orolin fails to teach or suggest this limitation, Vance teaches or suggests it. Vance teaches injecting a mixture of zero-valent iron and corn syrup. Ex. 1006 ¶¶ 118–122, Fig. 5. Dr. Wilson testifies that corn syrup is made up largely of sugars and would ferment to provide hydrogen. Ex. 1004 ¶ 348 (citing Ex. 1023, 1:43–47). The '709 patent makes clear that sugars are organic hydrogen donors. Ex. 1001, 6:57–60. Dr. Haselow testifies that corn syrup is an organic hydrogen donor. Ex. 1036, 66:1–4, 66:22–67:5.

Accordingly, the combination of Orolin, Vance, and Liskowitz teaches or suggests this limitation.

(5) "Supplying an organic hydrogen donor into the permeable pathways to . . . produce dechlorinating conditions such that indigenous anaerobic bacteria biodegrade residual concentrations of chlorinated solvents"

Claim 1 also recites "supplying an organic hydrogen donor into the permeable pathways to . . . produce dechlorinating conditions such that indigenous anaerobic bacteria biodegrade residual concentrations of chlorinated solvents." Ex. 1001, Reexamination Certificate, 2:13–18. As discussed above, Orolin discloses supplying an electron donor such as sodium benzoate. Orolin's bioremediation composition, including this electron donor, "promote[s] a high level of growth in indigenous micro-organisms," including "anaerobic . . . bacteria." Ex. 1005, 1:67–2:2. This treatment "activates the indigenous bacteria to degrade halogenated contaminants," including certain chlorinated solvents, such as "tetrachloroethylene," "trichloroethene," and "trichloroethane." *Id.* at 2:3–9. Orolin teaches that the presence of "the electron donor is crucial to the speed

and thoroughness with which the indigenous bacteria will degrade the halogenated contaminants." *Id.* at 12:21–24. Accordingly, Orolin teaches or suggests this limitation.

> *(6) "Wherein combined use of the zero valent metal and the organic hydrogen donor together in the permeable pathways accelerate dechlorination of contaminants in the subsoil and dechlorinate intermediates of the chlorinated solvents"*

Finally, claim 1 recites "wherein combined use of the zero valent metal and the organic hydrogen donor together in the permeable pathways accelerate dechlorination of contaminants in the subsoil and dechlorinate intermediates of the chlorinated solvents." Ex. 1001, Reexamination Certificate, 2:18–22. Petitioner argues both that Orolin expressly teaches its method results in accelerated dechlorination of contaminants and intermediates and that accelerated dechlorination of contaminants and intermediates would have been the natural result of the method taught by the combination of Orolin, Vance, and Liskowitz. Pet. 27–29, 54. Patent Owner argues that a person of ordinary skill in the art would not have expected Orolin's method to result in accelerated dechlorination. PO Resp. 28–29.

The '709 patent identifies both cis-1,2-dichloroethene ("cis-1,2-DCE") and vinyl chloride as intermediates of the chlorinated solvents. *Id.* at 2:36–39. As discussed above, Orolin discloses injecting both elemental iron and an electron donor into contaminated subsoil. Orolin also teaches that this composition "accelerat[es] the bioremediation of halogenated aliphatic and aromatic contaminated soils and ground water." Ex. 1005, 2:66–3:2. The invention of Orolin "is advantageous as it results in a faster degradation

of the contaminants." *Id.* at 3:5–7. Orolin discloses degradation of both cis-1,2-DCE and vinyl chloride using its method. *Id.* at code (57), 11:33–45. Further, Dr. Wilson testifies that Orolin's bioremediation method would degrade both the chlorinated solvents disclosed in Orolin and intermediates of those solvents. Ex. 1004 ¶¶ 226–229. Thus, Orolin teaches or suggests this limitation.

Thus, Petitioner has shown by a preponderance of the evidence that the combination of Orolin, Vance, and Liskowitz teaches or suggests all limitations of claim 1 and that a person of ordinary skill in the art would have had a reason to combine the teachings of Orolin, Vance, and Liskowitz with a reasonable expectation of success. Accordingly, Petitioner has shown that claim 1 would have been obvious over the combination of Orolin, Vance, and Liskowitz.

b. Claim 2

Claim 2 depends from claim 1 and recites a limitation requiring a "further . . . step of supplying a reducing agent into said permeable pathways to remove oxygen from groundwater and soil moisture." Ex. 1001, Reexamination Certificate, 2:23–26. Petitioner argues that Orolin teaches or suggests this limitation. Pet. 29, 57. Patent Owner does not argue to the contrary. PO Resp. 21–31.

Orolin discloses that its bioremediation composition includes ferrous sulfate. Ex. 1005, 15:35–62. Dr. Wilson testifies that ferrous sulfate is a reducing agent that would remove oxygen from groundwater and soil moisture. Ex. 1004 ¶ 237. Accordingly, Petitioner has shown by a preponderance of the evidence that claim 2 would have been obvious over the combination of Orolin, Liskowitz, and Vance.

c. Claim 3

Claim 3 depends from claim 1 and adds a limitation requiring that "the steps of supplying said mixture and said organic hydrogen donor [be] carried out by placing an injection rod into the subsoil and then injecting them under pressure through the injection rod." Ex. 1001, Reexamination Certificate, 2:27–31.

(1) Orolin, Liskowitz, and Vance

Petitioner argues that Orolin teaches or suggests this limitation. Pet. 30, 57. Patent Owner does not argue to the contrary. PO Resp. 21–31.

Orolin discloses injecting its bioremediation composition "under pressure into the sub-surface environment." Ex. 1005, 9:32–34. Orolin teaches that "[t]he pressurized injection method may be accomplished by using . . . any . . . piece of equipment that will sufficiently deliver the bioremediation compositions to the sub-surface environment." *Id.* at 9:43–47. Dr. Wilson testifies that a person of ordinary skill in the art would understand that a conduit would be required to accomplish Orolin's disclosed injection method and that an injection rod was a commonly used type of conduit for this purpose. Ex. 1004 ¶¶ 240–244. Accordingly, Petitioner has shown by a preponderance of the evidence that claim 3 would have been obvious over the combination of Orolin, Liskowitz, and Vance.

(2) Orolin and Vance

Petitioner also argues that claim 3 would have been obvious over the combination of Orolin and Vance, without taking into account the teachings of Liskowitz. Pet. 58–59. Patent Owner does not argue to the contrary. PO Resp. 21–31.

As discussed above, Orolin teaches or suggests the limitation added by claim 3. Thus, claim 3 would have been obvious over the combination of Orolin and Vance if and only if claim 1, from which claim 3 depends, would have been obvious over that combination of references. Above, we considered the obviousness of claim 1 over the combination of Orolin, Vance, and Liskowitz, but we relied on Liskowitz only for support for the finding that a person of ordinary skill in the art would have known how to adjust the concentration of zero-valent iron to permit both the biotic and the abiotic portions of the method to occur. Even without the disclosure of Liskowitz, however, there is sufficient evidence to maintain that finding, because both Orolin and Vance teach or suggest adjusting the amount of iron to account for site-specific conditions. Ex. 1005, 4:30–32 ("Differing environmental factors at each contaminated site determine the amount of the iron derivatives to be added to the bioremediation compositions."); Ex. 1006 ¶¶ 2–7 (teaching delivering zero-valent iron for same purpose as in claim 1, but not teaching any particular concentration or amount of iron). Accordingly, Petitioner has shown by a preponderance of the evidence that claim 3 would have been obvious over the combination of Orolin and Vance.

d. Claims 4, 10, and 13

Claim 4 depends from claim 3 and adds a limitation requiring a "preliminary step of injecting a gas under pressure through said injection rod and into the permeable pathways in said subsoil to establish preferential delivery pathways." Ex. 1001, Reexamination Certificate, 2:32–35. Claim 10 depends from claim 4 and adds a limitation requiring that "said gas [be] from the group of nitrogen and carbon dioxide." *Id.* at 6:61–62. Claim 13 depends from claim 4 and adds a limitation requiring "a final step of gas

injection to clear said injection rod and fluid conduit lines connected thereto." *Id.* at 7:4–6. Petitioner argues that claims 4, 10, and 13 would have been obvious over the combination of Orolin, Vance, and Liskowitz. Pet. 60–63. Other than the arguments discussed above with respect to claim 1, from which claims 4, 10, and 13 depend indirectly, Patent Owner does not argue to the contrary. PO Resp. 21–31.

Dr. Wilson testifies that a person of ordinary skill in the art would have understood that "for certain geological formations, the ability to deliver compositions (such as Orolin's bioremediation composition) will be naturally limited by the permeability of the geological formation." Ex. 1004 ¶ 305. Liskowitz teaches that compositions including "zero valence iron powder" can be delivered to "[t]ight geological formations containing clay or fractured rock" using "pressurized hydraulic injection or multiphase gas/liquid injection to overcome natural permeability limitations of the formation . . . and deliver desired quantities of zero valence iron powder into induced . . . channels within the remediation volume." Ex. 1008, 8:30–51. Liskowitz teaches using nitrogen as an injection gas. *Id.* Moreover, Liskowitz teaches creating channels in the geological formation either simultaneously with or before injection of the zero-valent iron powder. *Id.* at 8:52–60. Thus, and as discussed above with respect to claim 1, we agree with Petitioner that a person of ordinary skill in the art would have had reason to use the method of Liskowitz in combination with the method of Orolin and Vance when dechlorinating compounds in the subsoil in tight geological formations. Because that combination teaches or suggests using nitrogen to create channels in the formation before injecting the zero-valent iron composition, Petitioner has shown by a preponderance of the evidence

that claims 4 and 10 would have been obvious over the combination of Orolin, Vance, and Liskowitz.

Petitioner also argues that a person of ordinary skill in the art would have been motivated to clear the injection lines after injection was complete, both because there would have been an economic incentive to use all of the injected material and because cleaning injection equipment was standard practice. Pet. 62–63. Dr. Wilson testifies to these facts, Ex. 1004 ¶¶ 313–314, and the record contains no argument to the contrary. Accordingly, Petitioner has shown by a preponderance of the evidence that claim 13 would have been obvious over the combination of Orolin, Vance, and Liskowitz.

e. Claims 5 and 12

Claim 5 depends from claim 2 and adds a limitation requiring that the "reducing agent [be] sodium sulfite." Ex. 1001, 6:49–50. Claim 12 depends from claim 3 and adds a limitation requiring, "after the step of injecting the organic hydrogen donor, an additional step of injecting into the soil a sodium sulfite and nutrient solution to provide for further in-situ mixing and penetration of anaerobic stimulating products." *Id.* at 6:66–7:3. Petitioner argues that these claims would have been obvious over the combination of Orolin, Vance, and Rice. Pet. 63–65. Other than the arguments discussed above with respect to claim 1, Patent Owner does not argue to the contrary. PO Resp. 21–31.

As discussed above with respect to claim 3, even without the teachings of Liskowitz, Petitioner has shown the obviousness of claim 1 by a preponderance of the evidence. Thus, the failure to rely on Liskowitz with respect to claims 5 and 12 is not fatal to Petitioner's argument.

Rice teaches injecting sodium sulfite into the subsoil to deoxygenate the water used to carry the electron donor that dechlorinates the subsoil contaminants. Ex. 1009, 3:39–46, 3:58–4:6. Dr. Wilson testifies that a person of ordinary skill in the art would have had reason to combine the teachings of Rice with those of Orolin because the person would have understood that, "by depleting oxygen in the contamination area, desirable anaerobic activity (which may promote reductive dechlorination) will be enhanced, while aerobic activity will be decreased," and we credit this testimony. Ex. 1004 ¶¶ 323–324. Accordingly, Petitioner has shown by a preponderance of the evidence that claim 5 would have been obvious over the combination of Orolin, Vance, and Rice.

With respect to claim 12, Rice teaches applying its method multiple times to avoid the increase in contaminant concentration that may occur as contaminants continue to dissolve into the groundwater. Ex. 1009, 4:54–60. Dr. Wilson testifies that a person of ordinary skill in the art would have understood that such repeated applications "would cause in-situ mixing of, and additional penetration by, the previously injected composition," and we credit this testimony. Ex. 1004 ¶ 327. Accordingly, Petitioner has shown by a preponderance of the evidence that claim 12 would have been obvious over the combination of Orolin, Vance, and Rice.

f. Claim 6

Claim 6 depends from claim 1 and adds a limitation requiring that the "organic hydrogen donor further include[] vitamins B2 and B12." Ex. 1001, 6:51–52. Petitioner argues that this claim would have been obvious over the combination of Orolin, Vance, and Liskowitz. Pet. 30–31, 54–57. Other

than the arguments discussed above with respect to claim 1, Patent Owner does not argue to the contrary. PO Resp. 21–31.

Orolin discloses "yeast extracts" used in its compositions that can include "riboflavin B2" and "vitamin B12," among other compounds. Ex. 1005, 5:51–58. Accordingly, Petitioner has shown by a preponderance of the evidence that claim 6 would have been obvious over the combination of Orolin, Vance, and Liskowitz.

g. Claims 7 and 8

Claim 7 depends from claim 1 and adds a limitation requiring that "the mixture further include[] nutrients." Ex. 1001, 6:53–54. Claim 8 depends from claim 7 and specifies that the "nutrients are organic ammonia and ortho-phosphate." *Id.* at 6:55–56. Petitioner argues that these claims would have been obvious over the combination of Orolin, Vance, and Liskowitz. Pet. 31, 54–57. Other than the arguments discussed above with respect to claim 1, Patent Owner does not argue to the contrary. PO Resp. 21–31.

Orolin discloses that its bioremediation composition preferably includes "ortho phosphate." Ex. 1005, 6:13–16. Orolin also teaches that "ammonia/urea nitrogen will be added to the bioremediation solutions." *Id.* at 6:37–38. Accordingly, Petitioner has shown by a preponderance of the evidence that claims 7 and 8 would have been obvious over the combination of Orolin, Vance, and Liskowitz.

h. Claims 9, 15, and 16

Claim 9 depends from claim 1 and adds a limitation requiring that the "organic hydrogen donor [be] from the group consisting of lactate, proprionate, chitin, butyrate, acetate, sugars, glycerol tripolylactate, xylitol

pentapolylactate, and sorbitol hexapolylactate." Ex. 1001, 6:57–60. Claim 15 depends from claim 1 and adds a limitation requiring that the "metal [be] in a colloidal suspension." *Id.* at 8:2–3. Claim 16 depends from claim 15 and adds a limitation requiring that "the colloidal suspension include[] a reducing agent." *Id.* at 8:4–5. Petitioner argues that each of these claims would have been obvious over the combination of Orolin and Vance.[10] Other than the arguments discussed above with respect to claim 1, Patent Owner does not argue to the contrary. PO Resp. 21–31.

Vance teaches the use of a colloidal suspension of zero-valent iron in a carbohydrate such as corn syrup. Ex. 1006 ¶¶ 119, 122. Dr. Wilson testifies that Vance's corn syrup contains sugars and is a reducing agent. Ex. 1004 ¶¶ 278, 296. Accordingly, Petitioner has shown by a preponderance of the evidence that claims 9, 15, and 16 would have been obvious over the combination of Orolin and Vance.

i. Claim 11

Claim 11 depends from claim 1 and adds a limitation requiring that the "mixture including a zero valent metal [be] a colloidal suspension in a sodium sulfite solution." *Id.* at 6:63–65. Petitioner argues that claim 11 would have been obvious over the combination of Orolin, Vance, and Rice. Other than the arguments discussed above with respect to claim 1, Patent Owner does not argue to the contrary. PO Resp. 21–31.

[10] Although the Petition contains a section titled "Claims 9, 11, 15, and 16 ([Obvious over] Orolin, Vance, and Liskowitz)," Pet. 65, Petitioner argues instead that these claims would have been obvious over the combination of Orolin and Vance, or, in the case of claim 11, over the combination of Orolin, Vance, and Rice.

As discussed above, Vance teaches the use of a colloidal suspension of zero-valent iron, and the present record supports a finding that a person of ordinary skill in the art would have had reason to combine the teachings of Vance with those of Orolin. Ex. 1006 ¶¶ 119, 122. Rice teaches injecting sodium sulfite into the subsoil to deoxygenate the water used to carry the electron donor that dechlorinates the subsoil contaminants. Ex. 1009, 3:39–46, 3:58–4:6. Dr. Wilson testifies that a person of ordinary skill in the art would have had reason to combine the teachings of Rice with those of Orolin because the person would have understood that, "by depleting oxygen in the contamination area, desirable anaerobic activity (which may promote reductive dechlorination) will be enhanced, while aerobic activity will be decreased." Ex. 1004 ¶¶ 323–324. Accordingly, Petitioner has shown by a preponderance of the evidence that claim 11 would have been obvious over the combination of Orolin, Vance, and Rice.

j. Claim 14

Claim 14 depends from claim 1 and adds a limitation requiring that the "metal [be] iron." Ex. 1001, 8:1. Petitioner argues that claim 14 would have been obvious over the combination of Orolin, Liskowitz, and Vance. Pet. 31, 54–57. Other than the arguments discussed above with respect to claim 1, Patent Owner does not argue to the contrary. PO Resp. 21–31.

As discussed above, Orolin discloses that its bioremediation composition includes an "iron derivative" that may be "elemental iron." Ex. 1005, 4:42–47. Accordingly, Petitioner has shown by a preponderance of the evidence that claim 14 would have been obvious over the combination of Orolin, Liskowitz, and Vance.

k. Claims 17 and 18

Claim 17 depends from claim 1 and adds a limitation requiring that "the intermediates include cis-1,2-DCE." Ex. 1001, Reexamination Certificate, 2:36–37. Claim 18 depends from claim 1 and adds a limitation requiring that "the intermediates include vinyl chloride (VC)." *Id.* at 2:38–39. Petitioner argues that these claims would have been obvious over the combination of Orolin, Liskowitz, and Vance. Pet. 32–33, 54–57. Patent Owner disagrees. PO Resp. 30–31.

Orolin discloses that its bioremediation method degrades tetrachloroethylene and trichloroethene. Ex. 1005, 2:3–9. It also teaches that the contaminants are "thorough[ly] degrad[ed]," with no "final detectable production of a vinyl monomer such as vinyl chloride." *Id.* at 3:2–5. Orolin's process results in "the non-detection of vinyl chloride." *Id.* at code (57).

Dr. Wilson testifies that Orolin's degradation of tetrachloroethylene and trichloroethene necessarily would produce cis-1,2-DCE and vinyl chloride, so the non-detection of vinyl chloride means that Orolin's process creates and then degrades these intermediates. Ex. 1004 ¶¶ 257–261; Ex. 1037 ¶¶ 45–47. Patent Owner argues that Dr. Wilson is incorrect and that Orolin's process would not produce vinyl chloride in the first place, stalling at the production of (and not including the degradation of) cis-1,2-DCE, a phenomenon Patent Owner refers to as "cis stall," meaning that neither cis-1,2-DCE nor vinyl chloride would be an intermediate of the process. PO Resp. 30–31 (citing Ex. 2002 ¶¶ 126–129, 206, 207). According to Patent Owner, this would occur because of "sulfate reduction inhibiting dechlorination." *Id.*; *see also* PO Resp. 25 (citing Ex. 2002

¶¶ 127–129, 185) (arguing that "sulfates would compete for any hydrogen generated by [Orolin's] iron derivative" and any "molecular hydrogen generated on the surface of the ZVI would be oxidized by the sulfate reducing bacteria to produce hydrogen sulfide which would be toxic to chlorine reducing bacteria").

Petitioner replies that, although the effects to which Patent Owner refers might cause less activity of the chlorine-reducing bacteria, the bacterial activity would not be eliminated or stopped. Reply 13–14 (quoting Ex. 1036, 48:20–23; citing Ex. 1036, 50:14–51:15, 52:24–53:18; Ex. 1037 ¶¶ 46, 49; Ex. 2010; Ex. 2014, 2). Moreover, Petitioner argues that Orolin teaches that its process can avoid cis stall. *Id.* at 17–18 (quoting Ex. 1036, 61:3–9). Accordingly, Petitioner argues, Orolin's thorough degradation of tetrachloroethylene and trichloroethene necessarily would produce cis-1,2-DCE and vinyl chloride, and "Orolin's non-detection of [vinyl chloride] thus must be understood to mean" that the vinyl chloride was dechlorinated. *Id.* at 18 (citing Ex. 1036, 9:14–23, 59:16–21, 61:25–62:10; Ex. 1037 ¶¶ 45–47).

All that claims 17 and 18 require is the production of some cis-1,2-DCE and some vinyl chloride, followed by the degradation of at least some of each of these compounds. Ex. 1001, Reexamination Certificate, 2:36–39 ("wherein the intermediates include cis-1,2-DCE" and "vinyl chloride"). There exists a chemical pathway from tetrachloroethylene and trichloroethene through cis-1,2-DCE to vinyl chloride, and finally to ethene, and Orolin teaches starting with tetrachloroethylene and trichloroethene and ending with no detectable vinyl chloride. Ex. 1004 ¶¶ 257–261; Ex. 1005, code (57), 2:3–9, 3:2–5; Ex. 1036, 9:14–23; Ex. 1037 ¶¶ 45–47. There are

two possible reasons for this: either Orolin's process does not produce vinyl chloride in the first place (as Patent Owner argues), or Orolin's process produces some vinyl chloride and degrades it to an undetectable level (as Petitioner argues). The evidence of record supports the latter explanation over the former.

There is some evidence to support Patent Owner's theory that Orolin's process would stall at the production of cis-1,2-DCE due to sulfate reduction inhibiting dechlorination. First, Dr. Haselow testifies that this would occur. Ex. 2002 ¶¶ 127–129, 206. Second, Orolin discloses that its process "does not result in the final detectable production of a vinyl monomer such as vinyl chloride," which could be interpreted to mean that vinyl chloride is not produced at all. Ex. 1005, 3:2–5. Third, Dr. Haselow cites other record evidence to support his opinion. For example, Exhibit 2010 states that sulfide "exhibits inhibitory effects on the dechlorination and growth" of bacteria that would dechlorinate contaminants. Ex. 2010, 8. Exhibit 2010 also states "sulfate concentrations are the key factor that determines the extent of dechlorination, with high sulfate concentrations exhibiting inhibition due to the toxicity of the sulfate reduction product sulfide." *Id.* at 10.

We find more persuasive, however, the evidence supporting Petitioner's position that Orolin's process would not exhibit cis stall. First, Dr. Haselow testified that, even when sulfate reducing bacteria outcompete dechlorinating bacteria, they merely reduce the amount of hydrogen available for dechlorination, rather than eliminating the hydrogen altogether. Ex. 1036, 48:20–23. Even inhibition of dechlorination is far from certain given the sulfate concentrations disclosed by Orolin. Ex. 1005, 11:1–10; Ex.

1037 ¶ 46 (Dr. Wilson's testimony that a 5mM concentration of sulfate is higher than the concentration of sulfates in Orolin); Ex. 2010, 1 (disclosing that sulfate concentrations below 5 mM "did not inhibit the growth or metabolism of" dechlorinating bacteria). Thus, there is evidence that the conditions that allegedly could lead to cis stall were not present in Orolin. Moreover, Orolin's Example 1 shows degradation of cis-1,2-DCE, which Dr. Haselow testified was evidence that no cis stall occurred. Ex. 1005, 11:33–47; Ex. 1036, 61:3–9. Thus, Orolin's process could occur without cis stall. Accordingly, we find that the most likely explanation for Orolin's non-detection of vinyl chloride is not that cis stall prevented the formation of any vinyl chloride, but rather that vinyl chloride was produced by the degradation of cis-1,2-DCE and subsequently degraded. Because Orolin teaches a process in which cis-1,2-DCE and vinyl chloride are intermediates, Petitioner has shown by a preponderance of the evidence that claim 14 would have been obvious over the combination of Orolin, Liskowitz, and Vance.

C. Anticipation Grounds Based on Orolin, Vance, or Hamilton Beach and Obviousness Grounds Based on Hamilton Beach

Petitioner argues that claims 1–3, 6–8, 14, 17, and 18 of the '709 patent are anticipated by Orolin. Pet. 19–33. Petitioner also argues that claims 1, 3, 9, and 14–18 are anticipated by Vance and that claims 1, 3, 9, 14, 17, and 18 are anticipated by Hamilton Beach. Pet. 33–54. Finally, Petitioner argues that claims 1–5, 9, 10, 12–14, 17, and 18 would have been obvious over various combinations of Hamilton Beach, Permit Application, Liskowitz, and Rice. Pet. 67–74.

As discussed above, Petitioner has shown that all the challenged claims are unpatentable due to obviousness over various combinations of prior art including Orolin. Accordingly, we do not reach the question of whether the claims are unpatentable on any other ground. *Boston Scientific Scimed, Inc. v. Cook Group Inc.*, 809 F. App'x 984, 990 (Fed. Cir. Apr. 30, 2020) ("We agree that the Board need not address issues that are not necessary to the resolution of the proceeding" once Petitioner has prevailed on all its challenged claims); *In re Basell Poliolefine*, 547 F.3d 1371, 1379 (Fed. Cir. 2008) ("Having concluded that the Board properly affirmed the rejection of claims 1-52 of the '687 patent based on obviousness-type double patenting in view of the '987 patent, we need not address the remaining issues raised by Basell regarding the §§102(b) and 103(a) rejections, as well as the additional double patenting rejections. Accordingly, the Board's decision is affirmed."); *Beloit Corp. v. Valmet Oy*, 742 F.2d 1421 (Fed. Cir. 1984) (ITC having decided a dispositive issue, there was no need for the Commission to decide other issues decided by the presiding officer).

D. Motion to Strike

In its Sur-Reply, Patent Owner presents several arguments based on the fact that, although Orolin discloses that its components are dissolved in water, zero-valent iron cannot be dissolved in water. Patent Owner argues that this suggests that Orolin's "iron derivatives" cannot include zero-valent iron. *See, e.g.*, PO Resp. 17–19. Petitioner moves to strike these arguments, as well as Exhibits 2026–2029, which support these arguments. Mot. 1–5. Patent Owner opposes the motion. Opp. Mot. 1–5.

As discussed above, even when we consider the allegedly new arguments from Patent Owner's Sur-Reply, we are persuaded that Petitioner

has shown by a preponderance of the evidence that all the challenged claims would have been obvious. Accordingly, we determine that Petitioner's Motion to Strike is moot, and we dismiss it.

CONCLUSION[11]

Upon consideration of the papers and evidence before us, we determine that Petitioner has proven by a preponderance of the evidence that claims 1–4, 6–8, 10, 13, 14, 17, 18 are unpatentable as obvious over the combination of Orolin, Liskowitz, and Vance. Petitioner also has proven by a preponderance of the evidence that claims 3, 9, 15, 16 are unpatentable as obvious over the combination of Orolin and Vance. Finally, Petitioner has proven by a preponderance of the evidence that claims 5, 11, and 12 are unpatentable as obvious over the combination of Orolin, Rice, and Vance. We dismiss Petitioner's Motion to Strike as moot.

[11] Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this Decision, we draw Patent Owner's attention to the April 2019 *Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding*, 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. *See* 37 C.F.R. § 42.8(a)(3), (b)(2).

Claims	35 U.S.C. §	Reference(s)/Basis	Claims Shown Unpatentable	Claims Not Shown Unpatentable
1–3, 6–8, 14, 17, 18	102[12]	Orolin		
1, 3, 9, 14–18	102	Vance		
1, 3, 9, 14, 17, 18	102	Hamilton Beach		
1–4, 6–8, 10, 13, 14, 17, 18	103	Orolin, Liskowitz, Vance	1–4, 6–8, 10, 13, 14, 17, 18	
3, 9, 15, 16	103	Orolin, Vance	3, 9, 15, 16	
5, 11, 12	103	Orolin, Rice, Vance	5, 11, 12	
1, 3, 9, 14, 17, 18	103[13]	Hamilton Beach, Permit Application		
2, 5, 12	103	Hamilton Beach, Rice		
4, 10, 13	103	Hamilton Beach, Liskowitz		
Overall Outcome			1–18	

[12] For the reasons explained above in section C of our Analysis, we do not reach the grounds of anticipation by Orolin, anticipation by Vance, and anticipation by Hamilton Beach.

[13] For the reasons explained above in section C of our Analysis, we do not reach the grounds of obviousness over the combinations based on Hamilton Beach.

ORDER

It is hereby

ORDERED that Petitioner has proven by a preponderance of the evidence that claims 1–18 of U.S. Patent No. 7,531,709 C1 are unpatentable;

FURTHER ORDERED that, pursuant to 35 U.S.C. § 318(b), upon expiration of the time for appeal of this decision, or the termination of any such appeal, a certificate shall issue canceling claims 1–18 of U.S. Patent No. 7,531,709 C1;

FURTHER ORDERED that Petitioner's Motion to Strike is dismissed; 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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