

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

AIR LIQUIDE LARGE INDUSTRIES U.S. LP,
Petitioner,

v.

PRAXAIR TECHNOLOGY, INC.,
Patent Owner.

Case IPR2015-01075
Patent 8,690,476 B2

Before WILLIAM V. SAINDON, CHRISTOPHER L. CRUMBLEY, and
JEFFREY W. ABRAHAM, *Administrative Patent Judges*.

SAINDON, *Administrative Patent Judge*.

DECISION
Denying Institution of *Inter Partes* Review
37 C.F.R. § 42.108

I. INTRODUCTION

Petitioner requests an *inter partes* review of claims 1–12 and 15 of U.S. Patent No. 8,690,476 B2 (Ex. 1001, “the ’476 patent”). Paper 1, 3 (“Pet.”). Patent Owner filed a Preliminary Response (“Prelim. Resp.”). Paper 10.

We have jurisdiction under 35 U.S.C. § 314, which provides that an *inter partes* review may not be instituted “unless . . . there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition.” Upon consideration of the Petition and Preliminary Response, we do not institute an *inter partes* review.

A. Related Matters

The ’476 patent is also challenged in *Air Liquide Large Industries U.S. LP v. Praxair Technology, Inc.*, Case IPR2015-01074 (filed April 18, 2015) and a continuation-in-part of the application issuing as the ’476 patent, U.S. Patent Application No. 14/182,582, is currently in prosecution. Paper 8, 2; *see* Pet. 1. Patent Owner’s patent U.S. 7,078,011 B2 is also challenged by Petitioner in Cases IPR2015-01071, -01072, and -01073, filed April 18, 2015. Paper 8, 2; Pet. 1. The parties do not indicate any concurrent district court litigation, although Patent Owner indicates that a district court action has been filed in a district court but not yet served. Paper 8, 2.

B. The ’476 Patent

The ’476 patent was filed on May 25, 2012 and is directed to a method and system for storing hydrogen in a salt cavern with a permeation barrier. Ex. 1001, (22), (54). It is known, in general, to store hydrogen and

other gasses in underground salt caverns. *Id.* at 1:42–45. Such caverns are typically formed by first adding fresh water to large underground salt deposits to form brine and then removing the brine, leaving a void. *Id.* at 1:45–48. Hydrogen placed in such a salt cavern may still escape to the surface through small cracks in the salt formation, however, which could be dangerous because hydrogen is flammable. *Id.* at 1:64–2:7.

The '476 patent purports to solve this problem by taking advantage of the viscoplastic properties of salt. The hydrogen in the cavern is stored within a certain pressure range that causes a permeation barrier to be formed in the salt cavern. Specifically, this pressure range causes “a reduction in the size and the quantity of interconnected pores or voids within the walls 203 of the salt to form a permeation barrier 206.” *Id.* at 5:5–10, 12–18.

C. Illustrative Claim

Of the claims challenged by Petitioner, claims 1 and 12 are independent. Claim 1 is reproduced below (emphasis added):

1. A method for storing hydrogen product in a salt cavern, comprising:
removing hydrogen product from a hydrogen pipeline;
compressing the hydrogen product to produce a compressed hydrogen product;
introducing the compressed product of hydrogen into the salt cavern to produce stored hydrogen within the salt cavern;
maintaining the stored hydrogen at a pressure between a lower limit and an upper limit within the cavern, *whereby the salt cavern forms a substantially impermeable barrier to the stored hydrogen therein between the lower limit and the upper limit*, wherein the compressed hydrogen product introduced into the salt

cavern comprise a purity of at least 95% or greater.

D. Asserted Grounds and Prior Art

Petitioner asserts that claims 1–12 and 15 of the '476 patent are unpatentable over several listed grounds:

References	Basis	Claims
BGS ¹ and Foh ²	§ 102	1, 6–10, 12, and 15
BGS and Foh	§ 103	1, 6–10, 12, and 15
BGS and '011 ³	§ 103	1, 6–10, and 12
BGS, '011, and Foh	§ 103	11 and 15
BGS, Foh, Neiland, ⁴ and Tek ⁵	§ 103	2–5
BGS, Foh, Neiland, and 16 Tex. Admin. Code § 3.97 ⁶	§ 103	2–5

Petitioner also relies on the testimony of Dr. Joe L. Ratigan. Ex. 1009.

¹ D. J. Evans, *An Appraisal of Underground Gas Storage Technologies and Incidents, for the Development of Risk Assessment Methodology*, British Geological Survey: Sustainable and Renewable Energy Programme Open Report OR/07/023 (2007) (“BGS”) (Ex. 1002).

² Stephen Foh et al., *Underground Hydrogen Storage Final Report*, Institute of Gas Technology (1979) (Ex. 1003).

³ Morrow et al., U.S. Patent No. 7,078,011 B2 (issued on July 18, 2006) (Ex. 1004).

⁴ Joel D. Nieland, *Salt Cavern Thermodynamics—Comparison Between Hydrogen, Natural Gas, and Air Storage*, Solution Mining Research Institute Fall 2008 Technical Conference (Oct. 13–14, 2008) (Ex. 1005).

⁵ M. Rasin Tek, *Natural Gas Underground Storage: Inventory and Deliverability* (PennWell Corp. 1997) (Ex. 1006).

⁶ As found in Texas Register, Vol. 18, No. 90, pp. 8871–9027 (Dec. 3, 1993) (Ex. 1011).

II. ANALYSIS

A. Claim Construction

We interpret the claims of an unexpired patent using the broadest reasonable interpretation in light of the specification of the patent. 37 C.F.R. § 42.100(b); *In re Cuozzo Speed Techs., LLC*, 793 F.3d 1268, 1276 (Fed. Cir. 2015). Under the broadest reasonable interpretation standard, claim terms are given their ordinary and customary meaning, as would be understood by one of ordinary skill in the art in the context of the entire disclosure. *In re Translogic Tech. Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007). Any special definition for a claim term must be set forth with “reasonable clarity, deliberateness, and precision.” *In re Paulsen*, 30 F.3d 1475, 1480 (Fed. Cir. 1994).

1. *Substantially Impermeable Barrier / Permeation Barrier*

Independent claim 1 includes a step of “maintaining the stored hydrogen at a pressure between [certain limits], whereby the salt cavern forms a substantially impermeable barrier to the stored hydrogen therein.”⁷ Independent claim 12 includes a step of “forming a permeation barrier . . . so as to prevent substantially all of the stored hydrogen from passing therethrough.” Ex. 1001, 12:30–34.

Petitioner analyzes the term “substantially permeable barrier” and concludes it means “a salt cavern wall that is capable of retaining the large majority of a high purity hydrogen gas . . . but may still have some hydrogen permeation.” Pet. 9. With respect to “permeation barrier,” Petitioner states

⁷ The “whereby” clause is discussed separately below and is included here for context.

that “[i]t is clear that this is a relative term defined by a reduction in permeability over the pre-existing starting permeability.” *Id.* at 13 (citing Ex. 1009 ¶ 16).

Patent Owner argues the term “substantially permeable barrier” requires no special construction, that Petitioner’s construction is unduly broad (arguing that “substantial” is more than “majority”) and ambiguous (arguing that the phrase “majority” creates ambiguity). Prelim. Resp. 19–20. With respect to the “permeation barrier,” Patent Owner offers no explicit construction or analysis.

The ’476 patent does not discuss in any meaningful way a “substantially impermeable barrier,” but explicitly defines “permeation barrier”:

The term “permeation barrier” as used herein is intended to refer to a salt cavern that when pressurized and/ or thermally activated, restricts the passage of hydrogen flow through the walls of the salt. As a result, there is a reduction in the size and the quantity of interconnected pores or voids within the walls of the salt. Accordingly, this reduction in the size and quantity of interconnected pores or voids substantially minimizes or prevents the availability of flow paths for high purity hydrogen molecules of at least 95% purity and above, from escaping therein and thereafter through the surrounding rock salt of the salt cavern.

Ex. 1001, 3:54–65; *see also id.* at 5:12–15 (describing “permeation barrier” in the same manner). The ’476 patent indicates that the barrier is formed at a pressure of “greater than about 500 psig.” *Id.* at 5:25–27.

Reviewing the claims in view of the specification, it is apparent to us that one of ordinary skill in the art would understand that a “permeation

barrier” or a “substantially impermeable barrier” is a structural phenomenon that is *formed* in the walls of a salt cavern when subject to a sufficient quantity of pressure; a salt cavern having a permeation barrier has a lower permeability than a salt cavern without one. Dr. Ratigan’s testimony confirms this with respect to the term “permeation barrier.” Ex. 1009 ¶ 16 (“The permeability prior to being ‘pressurized and/or thermally activated’ should be improved upon as reflected by a lower [permeation] value.”); *see also* Pet. 13 (construing the term as “a relative term defined by a reduction in permeability over the pre-existing starting permeability”). Accordingly, there does not appear to be any dispute that a “permeation barrier” is something that is formed in the cavern walls to reduce the permeation of the cavern after it is formed.

With respect to “substantially impermeable barrier,” Petitioner seeks a much broader construction that requires no reduction in permeability. *See* Pet. 13. Petitioner’s declarant, Dr. Ratigan, testifies, without further explanation, that “substantially impermeable barrier” means “the salt cavern walls did not display a higher permeability to gasses than that expected of [salt].” Ex. 1009 ¶ 17. In other words, Dr. Ratigan testifies that a “substantially impermeable barrier” is nothing more than the walls of any given salt cavern. We do not credit Dr. Ratigan’s testimony on this point because it is conclusory and does not address the fact that the claim requires the barrier to be “formed” by maintaining the salt cavern at certain pressures.

As to the extent the barrier is impermeable, we agree with Patent Owner that “substantially” is clear and that construing “substantially” as “a large majority,” as Petitioner proposes, is both unwarranted and gives an unduly broad scope to the claim phrase. *See* Prelim. Resp. 19–20.

In view of the above, we construe “substantially impermeable barrier” and “permeation barrier,” in the context of the claims, as a barrier formed in a salt cavern from exposure to sufficient pressure such as to become substantially impermeable to hydrogen.

We recognize that we are construing two terms, used in different independent claims of the '476 patent, to refer essentially to the same thing. This is because, as claimed, they both refer to barriers *formed* in the walls of salt caverns via pressure to prevent hydrogen from escaping. We understand there may be a slight difference between the terms, but, on the present record, this distinction does not come into play and, as such, it is proper to construe these terms to be the same insofar as they are both directed to a formed barrier as construed above.⁸

2. *Depth Within the Cavern*

Claims 2–5 depend from claim 1 and specify various pressures inside the cavern in terms of “psi per linear foot of depth *within* the cavern.” (emphasis added). Petitioner argues that we should construe the term as “psi per linear foot of depth *of* the cavern” (emphasis added), i.e., the distance from the ground to the top of the cavern. Pet. 10–12. Patent Owner argues that the term is defined in the specification contrary to Petitioner’s offered construction. Prelim. Resp. 20–24.

The '476 patent describes the cavern depth as follows:

The cavern depth that starts at the top of the salt and ends at the bottom of the salt cavity is denoted as “d” and is defined as the vertical distance

⁸ Namely, we understand the difference to lie in that the claim 12 barrier includes a particular mode for forming the permeation barrier (reducing the porosity of the salt) whereas the claim 1 barrier includes no such limitation.

spanning from the top-most portion 204 to the bottom-most portion 207 of the salt cavern 3.

Ex. 1001 at 5:1–5. The '476 patent depicts cavern depth “d” in Figure 2, reproduced below:

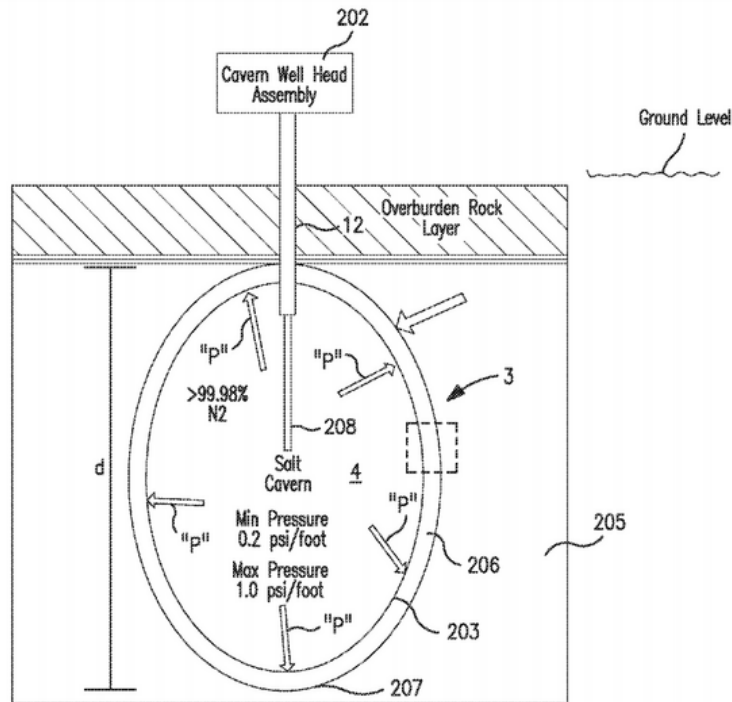


FIG. 2

Figure 2 of the '476 patent depicts salt cavern 3. Ex. 1001, 4:66. The cavern depth is indicated by span “d” and is described as the distance from top-most portion 204 (not shown in Fig. 2) to bottom-most portion 207 of salt cavern 3. *Id.* at 5:1–5.

Petitioner argues that the term “cavern depth” has two plain meanings, one based on depth being the distance between the roof and the floor of the cavern, the other based on the distance between ground level and the roof of the cavern. Pet. 10. Petitioner argues that we should construe the term according to the second meaning. With respect to the disclosure of cavern depth being span “d” in Figure 2, Petitioner asserts that “‘d’ is . . . clearly

not the depth within the cavern because it extends to the top of the salt formation.” *Id.* Petitioner concludes that cavern depth should be the distance between the ground and the cavern roof because the ’476 patent describes the Figure 2 cavern as having a “cavern depth” of 2500ft with a minimum pressure of 500psig, which makes the pressure per foot $500\text{psi}/2500\text{ft}=0.2\text{psi}/\text{ft}$, matching the value shown in Figure 2. *Id.* at 10–11 (citing Ex. 1001, 5:22–27). Petitioner lastly argues that Patent Owner, in a continuing application, changes the claim language from “depth within the cavern” to “depth of the cavern,” and offers this as evidence that we should construe “depth within the cavern” to mean “depth of the cavern” in the manner it proposes. *Id.* at 11.

Petitioner’s arguments are unpersuasive. First, Petitioner does not explain clearly why it believes that “d” is not the depth within the cavern. Even though “d” encompasses portions potentially above the void in the salt that defines the cavern itself, the specification states that cavern depth “starts at the top of the salt and ends at the bottom of the salt cavity” and further defines “d” as from the top-most portion to the bottom-most portion of the cavern. Ex. 1001, 5:1–5. This disclosure is consistent with giving weight to the “within” aspect of the phrase “depth within the cavern.”

Second, we are not persuaded that Figure 2 or the disclosure of 500psi of pressure within the cavern favors Petitioner’s construction. Petitioner’s calculation works out under either definition of “cavern depth,” because in either event we divide 500 by 2500 to get 0.2.

Third, even if we were convinced that the phrase “depth within the cavern” was made in error during prosecution of the ’476 patent, and should have been “depth of the cavern,” we decline to rewrite the claims. In this

case, the claims state “depth within the cavern” and the specification defines cavern depth in a manner consistent with the size of the cavern itself, rather than its depth from ground level. Even if, as Petitioner alludes, this definition provided by the specification is unworkable, unorthodox, or gives a nonsensical result, we “may not rewrite a claim even if giving a disputed claim its plain meaning would lead to a ‘nonsensical result.’” *Source Vagabond Sys. LTD. v. Hydrapak, Inc.*, 753 F. 3d 1291, 1301 (Fed. Cir. 2014) (citing *Chef Am., Inc. v. Lamb-Weston, Inc.*, 358 F.3d 1371, 1373 (Fed.Cir. 2004)) (explaining “courts may not redraft claims, whether to make them operable or to sustain their validity” even if the plain meaning of the claim leads to “a nonsensical result”). We decline to construe the claim in a manner inconsistent with the specification.

Reviewing the record before us, we determine that “depth within the cavern,” as would be understood by a person of ordinary skill in the art upon review of the specification, is the distance between the top of the salt and the bottom of the salt cavern.

3. *Whereby Clause*

Independent claim 1 includes a step of “maintaining the stored hydrogen at a pressure between [certain limits], whereby the salt cavern forms a substantially impermeable barrier to the stored hydrogen therein.” Petitioner offers several constructions of the clause, which we address in turn. *See* Pet. 16–18.

Petitioner first argues that the whereby clause in claim 1 is “not an element of the claim.” Pet. 16–17. We assume, by this, Petitioner means that the clause would not serve to patentably distinguish the claim over any prior art. Petitioner explains that the clause “describes the intended

consequence of maintaining the pressure in the salt cavern.” *Id.* at 16. In view of our discussion of “substantially impermeable barrier” above, however, we disagree that the whereby clause is not limiting. Instead, the whereby clause constrains the “maintaining the stored hydrogen” limitation to only those pressures that result in the formation of a substantially impermeable barrier. In this way, the whereby clause is limiting.

Petitioner next argues that the whereby clause is “inherently met by any art which describes any operating hydrogen salt cavern.” Pet. 17–18. Again, we disagree because the whereby clause specifies how the pressures are to be maintained to achieve a certain result—the *formation* of a substantially impermeable barrier. The evidence of record does not indicate that all pressures form a substantially impermeable barrier, such that not all hydrogen salt caverns would necessarily have a substantially impermeable barrier. *See* Ex. 1001, 5:23–27 (explaining that, at about 2500ft, the barrier forms at pressures *above 500psi*).

Petitioner lastly argues that the “whereby clause is obvious” and proceeds to offer a theory of obviousness. Pet. 18–21. Although no clear construction is offered, it appears Petitioner construes the clause as requiring the pressure in the cavern to be above a level to prevent creep but below a level that would cause fracturing. *See generally id.* We disagree because the whereby clause states that the pressures must be maintained in a manner “whereby the salt cavern *forms* a substantially impermeable barrier.” (claim 1) (emphasis added). The record does not establish that preventing creep or fracturing is the same thing as forming a substantially impermeable barrier.

In view of the above, we construe the whereby clause as limiting insofar as it states that the pressures must be maintained in a manner

“whereby the salt cavern forms a substantially impermeable barrier,” as claimed.

B. Petitioner’s Asserted Grounds

1. Independent Claim 1

In relevant part, independent claim 1 includes a step of “maintaining the stored hydrogen at a pressure between a lower limit and an upper limit within the cavern, whereby the salt cavern forms a substantially impermeable barrier to the stored hydrogen therein between the lower limit and the upper limit.” Petitioner sets forth its arguments that claim 1 is unpatentable in view of BGS (Ex. 1002), Foh (Ex. 1003), and ’011 (Ex. 1004) in an amalgamated section addressing at once three separate grounds. *See* Pet. 15–21. Of these three references, with respect to the “whereby” clause, Petitioner cites to BGS alone. *See id.* As discussed in our claim construction section, Petitioner sets forth three arguments regarding the whereby clause. We have determined already that the whereby clause is both limiting and not inherently met by simply “any operating salt cavern” because the cavern must be maintained at a pressure that *forms* a substantially impermeable barrier. *See id.* at 17. Further, Petitioner’s argument that the Imperial Chemical Industries Teesside Hydrogen salt cavern discussed in BGS inherently meets the substantially impermeable barrier because it has been in operation and “retain[s] the majority of [the hydrogen]” improperly attempts to rewrite the claim term “substantially” into “majority.” Thus, Petitioner’s first two arguments regarding the whereby clause are unpersuasive. *See* Pet. 16–18.

Petitioner’s last argument is that BGS discloses how cavern pressure is a “result affecting variable” in relation to salt cavern wall fracturing and

loss of gas inventory. Pet. 18–21. Petitioner shows that it was known in the art that too high of a pressure causes “fracturing of the salt and surrounding rocks.” *Id.* at 19 (citing Ex. 1002, 24–25). Petitioner also shows that it was known in the art that too low of a pressure will allow “fractures [to] evolve with time to give the characteristic tertiary creep response.” *Id.* at 20 (citing Ex. 1002, 25, 125). Accordingly, Petitioner has established that pressure is a variable known to yield certain results, the result being maintaining the structure of the existing salt cavern walls to prevent fracture. Claim 1, however, is directed to pressures that *form a substantially impermeable barrier*. The record before us does not establish that preventing fractures is the same as forming a barrier; Petitioner does not address adequately whether pressure was known as a variable for forming a substantially impermeable barrier. Thus, Petitioner has not shown a reasonable likelihood that the subject matter of claim 1 would have been anticipated or obvious on this record.

2. *Independent claim 12*

In relevant part, independent claim 12 includes steps of: “forming a permeation barrier” and “regulating the pressure of the salt cavern . . . to maintain the permeation barrier.” As with claim 1, Petitioner discusses three grounds involving claim 12 simultaneously and without distinction. Pet. 21–23. Petitioner argues that these limitations are met by “BGS[’s] teach[ing of] regulating the pressure of a salt cavern to achieve this functionality.” *Id.* at 22. By “this functionality,” it appears Petitioner means “to facilitate the ability to store the hydrogen gas while maintaining the structural integrity of the cavern.” *Id.*

Petitioner's ground does not address adequately the step of "forming a permeation barrier." The record before us does not establish that maintaining the structural integrity of the cavern the same as forming a barrier; for example, the former appears to be an attempt to keep the structure of the cavern the same whereas the latter attempts to modify the structure of the cavern. Thus, Petitioner has not shown a reasonable likelihood that the subject matter of claim 12 would have been anticipated or obvious on this record.

3. *Dependent Claims 2–5*

These claims set forth particular maximum and minimum pressures at which the salt cavern is maintained to form a substantially impermeable barrier. Petitioner asserts that Neiland, Tek, Morrow, and/or 16 Tex. Admin. Code §3.97 (2007) describes these pressures. Pet. 26–27 (citing Ex. 1005, 4; Ex. 1005, 13, 17; Ex. 1006, 282–283, Ex. 1011). These pressures, however, are described in terms of the depth of the cavern (ground to ceiling) rather than the "depth within the cavern" (top of salt to floor) claimed. *See id.* Petitioner does not discuss pressures measured by "depth within the cavern," as claimed. Because Petitioner relies on improper constructions of "substantially impermeable barrier" and "depth within the cavern," Petitioner fails to show adequately that either the claimed relationship was known, obvious, or that a prior art cavern described a cavern operating at the claimed pressures such as to inherently form a substantially impermeable barrier. Accordingly, Petitioner has not shown a reasonable likelihood that the subject matter of claims 2–5 would have been obvious on this record.

4. Remaining Claims

All remaining challenged claims (6–11 and 15) depend from claims 1 or 12 and the grounds addressing the remaining claims suffer the same deficiencies.

III. ORDER

In view of the foregoing, it is hereby ORDERED that the Petition is *denied* and that no *inter partes* review is instituted.

IPR2015-01075
Patent 8,690,476 B2

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