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UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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*Ex parte* PAUL J. BERLOWITZ, TIMOTHY ANDREW BARCKHOLTZ,  
and ANITA S. LEE

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Appeal 2018-009128  
Application 14/207,728  
Technology Center 1700

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Before ROMULO H. DELMENDO, KAREN M. HASTINGS,  
DONNA M. PRAISS, *Administrative Patent Judges.*

PRAISS, *Administrative Patent Judge.*

DECISION ON APPEAL<sup>1</sup>

Pursuant to 35 U.S.C. § 134(a), Appellant appeals from the Examiner’s decision to reject claims 1–4 and 6–21.<sup>2</sup> We have jurisdiction under 35 U.S.C. § 6(b).

We AFFIRM.

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<sup>1</sup> In this Decision, we refer to the Specification filed Mar. 13, 2014 (“Spec.”), the Final Office Action dated Nov. 30, 2017 (“Final Act.”), the Appeal Brief filed Apr. 30, 2018 (“Appeal Br.”), the Examiner’s Answer dated June 28, 2018 (“Ans.”), and the Reply Brief filed Sept. 25, 2018 (“Reply Br.”).

<sup>2</sup> We use the word “Appellant” to refer to “applicant” as defined in 37 C.F.R. § 1.42. ExxonMobil Research and Engineering Company is identified as the real party in interest. Appeal Br. 3.

STATEMENT OF THE CASE

The invention relates to the use of molten carbonate fuel cells in the processing or production of cement. Spec. ¶ 3. The Specification describes molten carbonate fuel cells as utilizing hydrogen or other fuels to generate electricity. *Id.* ¶ 5. The Specification defines “reformable fuel” as a fuel that contains carbon hydrogen bonds that can be reformed to generate H<sub>2</sub>. *Id.* ¶ 56. According to the Specification, CO is not considered a reformable fuel under this definition, although CO can participate in a water gas shift reaction to form hydrogen. *Id.*

Claims 1 and 19, reproduced below, are illustrative of the subject matter on appeal (emphasis added).

1. A method *for producing cement*, the method comprising:
  - introducing *a fuel stream comprising a reformable fuel* into an anode of a molten carbonate fuel cell, into an internal reforming element associated with the anode, or into a combination thereof;
  - in a process for production of cement, heating a cement kiln to form a cement product and a cement kiln exhaust;
  - introducing a cathode inlet stream comprising CO<sub>2</sub> and O<sub>2</sub> into a cathode of the fuel cell, the cathode inlet stream comprising at least a portion of the cement kiln exhaust; and
  - generating electricity within the molten carbonate fuel cell.

Appeal Br. 15 (Claims Appendix).

19. A method *for producing cement*, the method comprising:
  - introducing *a fuel stream comprising a reformable fuel* into an anode of a molten carbonate fuel cell, into an internal reforming element associated with the anode, or into a combination thereof;

in a process for production of cement, heating a cement kiln to form a cement product and a cement kiln exhaust;

introducing a cathode inlet stream comprising CO<sub>2</sub> and O<sub>2</sub> into a cathode of the fuel cell, the cathode inlet stream comprising at least a portion of the cement kiln exhaust; and

generating electricity within the molten carbonate fuel cell,

*wherein the reformable fuel introduced into the anode, into the internal reforming element associated with the anode, or into the combination thereof, comprises a reformable hydrogen content, a ratio of the reformable hydrogen content to a net amount of hydrogen reacted at the anode being at least about 1.5.*

*Id.* at 17–18.

#### ANALYSIS

We review the appealed rejections for error based upon the issues Appellant identifies, and in light of the arguments and evidence produced thereon. *Ex parte Frye*, 94 USPQ2d 1072, 1075 (BPAI 2010) (precedential) (cited with approval in *In re Jung*, 637 F.3d 1356, 1365 (Fed. Cir. 2011) (“[I]t has long been the Board’s practice to require an applicant to identify the alleged error in the examiner’s rejections.”). After considering the argued claims in light of the case law presented in this Appeal and each of Appellant’s arguments, we are not persuaded of reversible error in the appealed rejections.

The Examiner rejects claims 1–4 and 6–21 as follows. Final Act. 4–12.

<b>Claim(s) Rejected</b>	<b>35 U.S.C. §</b>	<b>Reference(s)/Basis</b>
1–4, 6–8, 10–12, 14–18	103	Keefer, <sup>3</sup> Shima <sup>4</sup>
9	103	Keefer, Shima, Lopez <sup>5</sup>
13	103	Keefer, Shima, Cui, <sup>6</sup> Nakazawa <sup>7</sup>
19–21	103	Keefer, Shima, Cui

Appellant separately argues the rejections of independent claims 1 and 19. Appeal Br. 6–14. Therefore, in view of the lack of arguments directed to the dependent claims, claims 2–4, 6–8, 10–12, and 14–18 stand or fall with claim 1 and claims 20 and 21 stand or fall with claim 19 from which they depend. 37 C.F.R. § 41.37(c)(1)(iv). We consider the arguments advanced by Appellant in support of patentability of claim 1 to the extent applicable to the separate rejections of claims 9 and 13. We separately address claims 1 and 19 below.

### *Claim 1*

Appellant contends that the Examiner erred in rejecting claim 1 over the combined teachings of Keefer and Shima based on the showing of unexpected results and long-felt need. Appeal Br. 10–12. According to Appellant, “a need to provide a suitable method for reducing CO<sub>2</sub> emissions in a practical manner has been felt in the cement industry since at least

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<sup>3</sup> US 2003/0143448 A1, published July 31, 2003.

<sup>4</sup> US 2011/0044880 A1, published Feb. 24, 2011.

<sup>5</sup> US 4,372,092, Feb. 8, 1983.

<sup>6</sup> US 2011/0104577 A1, May 5, 2011.

<sup>7</sup> US 5,134,043, July 28, 1992.

1998.” *Id.* at 10. Appellant asserts that this is supported by the Declaration of Paul J. Berlowitz dated August 15, 2018 (“Berlowitz Declaration”) and a presentation that Appellant contends was made in 1998 and published in pdf format in 2004 at [www.wbcscement.org/pdf/tfl/prghgt42.pdf](http://www.wbcscement.org/pdf/tfl/prghgt42.pdf) (“Hendriks”).<sup>8</sup> According to Appellant, Hendriks is referenced numerous times in a subsequent 2008 report by the International Energy Agency Greenhouse Gas R&D Programme, titled “CO<sub>2</sub> Capture in the Cement Industry” (“2008 Report”), which allegedly provides “the current state of the art (in 2008) for mitigating CO<sub>2</sub> emissions during cement manufacture.” *Id.* Appellant points to Table 1 of the 2008 Report to establish that the two primary methods of carbon capture depicted allow for avoidance of 77% and 52% of CO<sub>2</sub> emissions. *Id.* at 11. Appellant compares these CO<sub>2</sub> emissions statistics with the 90% or greater capture in Table A of Appellant’s Specification, but acknowledges that Table A is not a direct comparison with Table 1 of the 2008 Report. *Id.* According to Appellant, the ratio of total CO<sub>2</sub> captured to CO<sub>2</sub> emitted in Table 1 of the 2008 Report corresponds to a CO<sub>2</sub> reduction of only 82%, therefore, at 90% or greater, “Table A provides a clear benefit in addressing this long-felt need for improving CO<sub>2</sub> reduction during cement manufacture.” *Id.*

Appellant asserts that unexpected results relative to existing solutions has been demonstrated because the Berlowitz Declaration establishes “the complete lack of any reference with even a hint or a suggestion of combining a molten carbonate fuel cell with cement production in order to

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<sup>8</sup> C.A. Hendriks et al., *Emission Reduction of Greenhouse Gases from the Cement Industry*. According to the Berlowitz Declaration, the Hendriks article was presented at the 4<sup>th</sup> International Conference on Greenhouse Gas Control Technologies in 1998. Berlowitz Decl. ¶ 3.

reduc[e] or minimize CO<sub>2</sub> emissions while also generating substantial amounts of power.” *Id.* at 12. Appellant also argues that the prior art references relied upon by the Examiner either lack the molten carbonate fuel cell portion of claim 1 or the cement production portion of claim 1, therefore no meaningful comparison can be made. *Id.* at 12–13. Appellant asserts that Shima and Lalande<sup>9</sup> have no power production and would be at least qualitatively similar to the comparisons provided in the Berlowitz Declaration or paragraph 35 in the Specification, thus, “the ability to recover CO<sub>2</sub> while producing substantial electrical power is unexpected.” *Id.* at 13.

The Examiner responds that there is no evidence that the asserted long felt need persisted or that other attempts to solve the problem have been unsuccessful. Ans. 13. The Examiner finds that the problem appears to have been solved by others prior to Appellant, citing Shima’s separation and removal of CO<sub>2</sub>, which can be recovered and used in other processes, and Lalande’s disclosure of various strategies to reduce emissions by improving energy efficiency, using waste as alternative fuel, and using fly ash to replace cement in concrete. *Id.* (citing Lalande ¶ 25). The Examiner also finds that Lalande teaches greatly reducing or eliminating CO<sub>2</sub> production from cement clinker manufacture by catalyzing the hydration of CO<sub>2</sub> into a solution of bicarbonate ions and hydrogen ions wherein the bicarbonate ions react with metals ions to precipitate an environmentally harmless carbonated metal. *Id.*

Regarding unexpectedly better results relative to existing solutions, the Examiner responds that Keefer is the closest prior art reference because it is drawn to a method of operating a fuel cell that allows for carbon dioxide

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<sup>9</sup> US 2004/0129181 A1, published July 8, 2004.

utilization. *Id.* at 14. The Examiner further responds that Shima is relied upon for teaching conventional cement manufacturing methods which generate excess CO<sub>2</sub> gas. *Id.* The Examiner determines that cement production would have been an intended use for the fuel cell method from among process methods that produce excess carbon dioxide. *Id.*

In the Reply Brief, Appellant contends that because claim 1 explicitly produces cement, cement production is not an intended use. Reply Br. 3. According to Appellant, the Examiner's analysis is improper because the invention is the realization that unexpected benefits could be achieved by integrating a cement production process with the operation of molten carbonate fuel cells. *Id.* (citing Spec. ¶¶ 24, 25).

Appellant's arguments do not persuade us that the Examiner reversibly erred in rejecting claim 1 as obvious over the teachings of Keefer and Shima when considered together with Appellant's objective evidence of non-obviousness. Accordingly, we sustain the Examiner's rejection for essentially those reasons expressed in the Answer, including the Response to Argument section, and we add the following primarily for emphasis.

In rejecting claims under 35 U.S.C. § 103, it is incumbent upon the Examiner to establish a factual basis to support the legal conclusion of obviousness. *See In re Fine*, 837 F.2d 1071, 1073 (Fed. Cir. 1988). In so doing, the Examiner must make the factual determinations set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 17 (1966) (noting that 35 U.S.C. § 103 leads to three basic factual inquiries: (1) the scope and content of the prior art; (2) the differences between the prior art and the claims at issue; and (3) the level of ordinary skill in the art). If the Examiner's burden is met, the burden then shifts to the Appellant to overcome the prima facie case with

argument and/or evidence. Obviousness is then determined on the basis of the evidence as a whole and the relative persuasiveness of the arguments. *See In re Oetiker*, 977 F.2d 1443, 1445 (Fed. Cir. 1992).

Appellant does not rebut the Examiner's findings (Ans. 13–14) that Keefer is the closest prior art reference and that Lalande details a variety of strategies for reducing emissions subsequent to the 2008 Report. Instead, Appellant argues that there are “unexpected benefits . . . achieved by integrating a cement production process with operation of molten carbonate fuel cells.” Reply Br. 3. According to Appellant, an unexpected results comparison cannot be made to a process that does not integrate a cement production process. *Id.* The difficulty with Appellant's argument is that Keefer's process takes and uses a CO<sub>2</sub> effluent gas stream to produce electricity and Appellant has not shown how sourcing the CO<sub>2</sub> from a cement production process produces unexpected results compared to Keefer's process. If the unexpected result is only that Appellant's effluent gas stream is derived from a cement manufacturing operation, the effluent from a cement manufacturing operation would have to unexpectedly produce a CO<sub>2</sub> effluent gas stream. That, however, is not the case in view of Shima.

The burden of establishing that unexpected results support a conclusion of nonobviousness rests with Appellant. *In re Huang*, 100 F.3d 135, 139 (Fed. Cir. 1996). “[W]hen unexpected results are used as evidence of nonobviousness, the results must be shown to be unexpected compared with the closest prior art.” *In re Baxter Travenol Labs.*, 952 F.2d 388, 392 (Fed. Cir. 1991). “[I]t is not enough to show that results are obtained which differ from those obtained in the prior art: that difference must be shown to

be an unexpected difference.” *See In re Klosak*, 455 F.2d 1077, 1080 (CCPA 1972) (emphasis in original).

The problem with Appellant’s long-felt need argument is that neither the Berlowitz Declaration nor Appellant addresses alternative processes identified by the Examiner such as Lalande to establish that the cement manufacturing industry lacked a more efficient cement manufacture process up until Appellant’s invention. The Berlowitz Declaration asserts that the 2008 Report “is believed to be representative of the state of the art for mitigation of CO<sub>2</sub> emissions during cement manufacture at the time of filing.” Berlowitz Decl. ¶ 5. The Berlowitz Declaration, however, fails to provide any reasoning or evidence to support the assertion that no additional processes were known in the art besides those in Table 1 of the 2008 Report and that no technological improvements occurred between 2008 and Appellant’s 2014 application filing date. Berlowitz Decl. ¶ 5. The statement, therefore, is of little probative value. *See* 37 C.F.R. § 42.65(a) (opinion testimony that does not disclose underlying facts or data “is entitled to little or no weight”); *Ashland Oil, Inc. v. Delta Resins & Refractories, Inc.*, 776 F.2d 281, 294 (Fed. Cir. 1985) (a lack of objective support for expert opinion “may render the testimony of little probative value in a validity determination”). Nothing requires a fact finder to credit unexplained testimony of an expert. *Rohm and Haas Co. v. Brotech Corp.*, 127 F.3d 1089, 1092 (Fed. Cir. 1997).

Even if the time span between Hendriks and Appellant’s filing date were sufficient to establish long-felt need, Patent Owner has not addressed Lalande’s disclosure of other techniques for reducing CO<sub>2</sub> emissions in the cement production industry. Lalande ¶ 25; Ans. 13. Therefore, the evidence

cited in this appeal record is insufficient to establish that any long-felt need was solved by Appellant's process, as opposed to the prior art techniques reflected in Lalande.

In sum, Appellant's position (Reply Br. 3) that the Examiner failed to examine claim 1 as a whole is not persuasive of error because after thoroughly considering Appellant's objective evidence of non-obviousness together the teachings of Keefer and Shima, the preponderance of the evidence supports the Examiner's determination that a person having ordinary skill in the art would have known that cement production produces a high concentration excess of CO<sub>2</sub> gas to supply to the fuel cell method of Keefer which teaches utilizing CO<sub>2</sub> to produce electricity. Shima ¶ 18; Keefer ¶¶ 3, 111, Fig. 6). Accordingly, we affirm the Examiner's rejection of claim 1 as well as claims 2–4 and 6–18 under 35 U.S.C. § 103 over Keefer and Shima.

#### *Claim 19*

Appellant contends that the Examiner erred in rejecting claim 19 because molecular hydrogen (H<sub>2</sub>) does not have carbon-hydrogen bonds and, therefore, does not meet the express definition of "reformable fuel" set forth in the Specification. Appeal Br. 7 (citing Spec. ¶ 57). According to Appellant, the reformable hydrogen content of the reformable fuel introduced into the anode required by claim 19 cannot be determined based only on the fuel utilization because any H<sub>2</sub> present in the fuel stream is not considered reformable fuel by definition. *Id.* Appellant provides the Declaration of Timothy A. Barckhotez, a named inventor, dated March 2, 2017 ("Barckhotez Declaration") as support for the argument that Keefer's

reformable hydrogen content to reformable fuel ratio does not meet the requirements of claim 19 because it is 1.3 or less. *Id.* at 8. Appellant contends that neither Shima nor Cui cures this deficiency of Keefer because Shima does not disclose a fuel cell and “the ratio in Cui could be less than 1.0.” *Id.* at 8–9 (citing Cui ¶¶ 61, 66, 127).

The Examiner responds that Keefer teaches the use of natural gas as the fuel gas and natural gas by definition is comprised of hydrocarbons, specifically methane (CH<sub>4</sub>). Ans. 12 (citing Keefer ¶ 23). Regarding the ratio required by claim 19, the Examiner finds that Cui teaches a per pass fuel utilization of less than 50% and the use of hydrogen rich fuels so the fuel used by the method of Keefer, Shima, and Cui would be a reformable fuel. The Examiner further finds that the reformable hydrogen content in the reformable fuel versus the net hydrogen reacted at the anode in the method of Keefer, Shima, and Cui would be a value greater than or equal to 2.0 (the higher ratio recited in dependent claim 20) because the net hydrogen reacted at the anode is 1 (reformable fuel) divided by less than 0.5 (fuel utilized) which would be greater than or equal to 2.0. *Id.* at 12.

In the Reply Brief, Appellant maintains that because hydrogen cannot be a reformable fuel based on the definition in the Specification, hydrogen is excluded from the definition of reformable fuel. Reply Br. 2. Appellant contends that the ratio cannot be determined based only on fuel utilization because hydrogen must be excluded in determining the claimed ratio. *Id.*

Appellant’s arguments do not persuade us that the Examiner reversibly erred in rejecting claim 19 over the cited prior art references. Appellant does not dispute the Examiner’s use of less than 0.5 for the fuel utilization rate used in determining the ratio disclosed by the cited prior art

combination. Appellant does not dispute the Examiner's finding that Keefer discloses a reformable fuel (natural gas) that meets the definition provided by paragraph 56 of the Specification. Appellant's assertion that the claimed ratio of hydrogen content in the reformable fuel to hydrogen reacted at the anode would not be met by the combination of Keefer, Shima, and Cui because the prior art fuel stream contains hydrogen in addition to reformable fuel as defined by the Specification, which would reduce the value of the numerator in the ratio, is not persuasive of reversible error for a number of reasons.

First, Appellant's argument does not address the value of the denominator used by the Examiner to calculate the claimed ratio. The Examiner finds the fuel utilization rate would be less than 0.5. Ans. 12. Using this fuel utilization rate in the computation set forth in the Barckholtz Declaration confirms the Examiner's calculation of a ratio greater or equal to 2.0. *Compare* Ans. 12 *with* Barckholtz Decl. ¶ 15.

Second, the calculations provided in the Barckholtz Declaration are based on unsupported assumptions about a "conventional operation" having a fuel utilization of 75%. Barckholtz Decl. ¶¶ 7, 10, 15.

Third, Appellant's assertion that H<sub>2</sub> is present in the prior art fuel stream to reduce the numerator in the claimed ratio does not adequately address how that fact necessarily drives the value of the ratio computed by the Examiner to below the claimed amount given that the value is also impacted by the denominator.

Fourth, the calculations provided in the Barckholtz Declaration that assume an anode feed gas containing 85 vol% hydrogen and 15 vol% methane are based on an embodiment disclosed in Keefer that includes

recycled hydrogen in the feed stream. Barckholtz Decl. ¶¶ 8, 11. In a determination of obviousness, a reference may be relied upon for all that it would have reasonably suggested to one having ordinary skill in the art. *Merck & Co. Inc. v. Biocraft Labs., Inc.*, 874 F.2d 804, 807 (Fed. Cir. 1989) (“That the [prior art] patent discloses a multitude of effective combinations does not render any particular formulation less obvious.”). As noted in the Barckholtz Declaration, for Keefer’s conventional operation embodiment, it can be assumed that all of the fuel in the anode feed gas is methane, which is a reformable fuel. Barckholtz Decl. ¶ 15.

Because we are not persuaded of error in the Examiner’s finding that the combination of Keefer, Shima, and Cui discloses the method of claim 19 including the claimed ratio, we affirm the Examiner’s rejection of claim 19 as well as claims 20–21 under 35 U.S.C. § 103.

#### CONCLUSION

For these reasons and those the Examiner provides, we uphold the Examiner’s rejection of claims 1–4, 6–21 under 35 U.S.C. § 103 as obvious over the cited prior art references.

DECISION SUMMARY

In summary:

<b>Claims Rejected</b>	<b>35 U.S.C. §</b>	<b>Reference(s)/Basis</b>	<b>Affirmed</b>	<b>Reversed</b>
1-4, 6-8, 10-12, 14-18	103	Keefer, Shima	1-4, 6-8, 10-12, 14-18	
9	103	Keefer, Shima, Lopez	9	
13	103	Keefer, Shima, Cui, Nazakawa	13	
19-21	103	Keefer, Shima, Cui	19-21	
<b>Overall Outcome</b>			1-4, 6-21	

TIME PERIOD FOR RESPONSE

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a)(1)(iv).

AFFIRMED