

NOTE: This disposition is nonprecedential.

**United States Court of Appeals
for the Federal Circuit**

IN RE: LI LI, QUNZHU LI,
Appellants

2024-1209

Appeal from the United States Patent and Trademark
Office, Patent Trial and Appeal Board in No. 13/576,565.

Decided: April 8, 2025

LI LI, Luoyang, Henan, China, pro se.

QUNZHU LI, Luoyang, Henan, China, pro se.

JUSTIN BOVA, Office of the Solicitor, United States Patent and Trademark Office, Alexandria, VA, for appellee Coke Morgan Stewart. Also represented by KAKOLI CAPRIHAN, AMY J. NELSON.

Before TARANTO, CLEVINGER, and HUGHES, *Circuit Judges*.

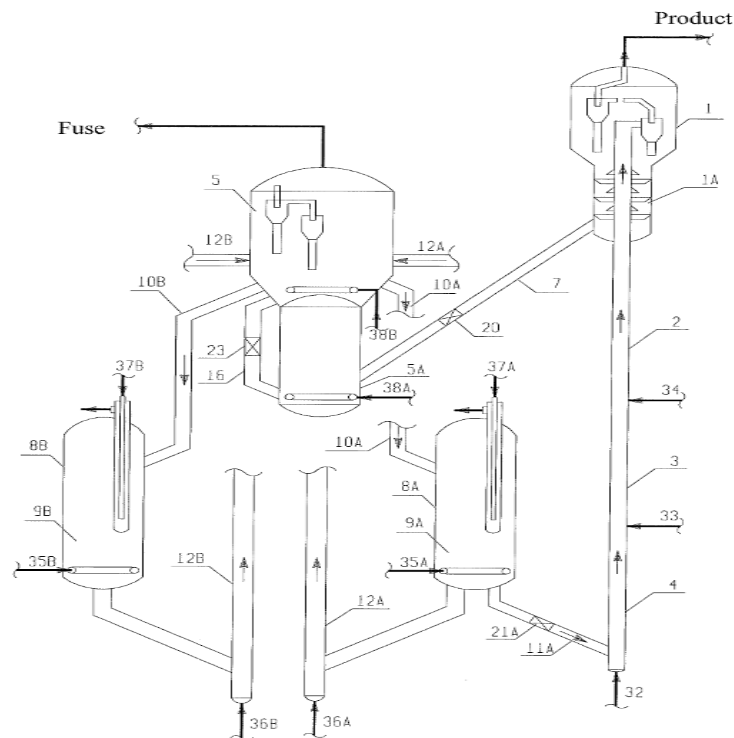
PER CURIAM.

Li Li and Qunzhu Li (hereafter “applicants”) filed U.S. Patent Application No. 13/576,565 on August 1, 2012. The

565 application relates to fluid catalytic cracking, a process in which hydrocarbon materials react with a catalyst to form oil and gas products that are then separated from the catalyst. The assigned patent examiner in the United States Patent and Trademark Office (PTO) rejected all pending claims of the application for obviousness. Applicants appealed to the PTO's Patent Trial and Appeal Board (Board), which affirmed the rejection of the claims. *Ex parte Li*, No. 2023-000079, 2023 WL 3560449, at *1 (P.T.A.B. May 18, 2023) (*Decision*). Applicants appeal the Board decision to this court. We now affirm.

I

Figure 2 of the '565 application depicts the core of the described processes. Applicants' Appendix (Appx.) 212.



The described processes involve using a catalyst in oil and gas production and then regenerating the catalyst for further use. Raw hydrocarbon material reacts with a

catalyst in one or more reaction zones of the riser reactor (reference numerals 2 and 3 in figure 2) to form oil and gas. '565 App. ¶¶ 92, 94.¹ The resulting materials then enter a disengager (1), which separates the catalyst from the oil and gas. *Id.* at Abstract; *id.* ¶ 92. The catalyst is then steam-stripped at the stripping section (1A) before entering the regenerator (5). *Id.* at Abstract; *id.* ¶¶ 14, 92. In the regenerator (5), the catalyst is burned in the presence of oxygen-containing gas before being cooled by catalyst coolers (8A and 8B). *Id.* at Abstract; *id.* ¶¶ 84–85, 92. After the catalyst is cooled, it enters the mixing buffer space (9A or 9B) in the lower part of the catalyst cooler before returning to the riser reactor. *Id.* ¶¶ 84, 92.

The cooled catalyst can be used to control the temperature in the reactor “so as to promote hydrogen transfer, isomerization, and aromatization reaction[s] and reduce coke and gas yield.” *Id.* ¶¶ 10–11. When two catalyst coolers are used, one catalyst cooler (8A) is connected to the first reaction zone (3), where the catalyst’s temperature adjusts the reaction temperature in that zone, and the other catalyst cooler (8B) is connected to the regenerator (5) and regulates the temperature there. *Id.* ¶¶ 84–85, 95–96. Reaction temperature can also be controlled by adjusting the ratio of the catalyst to the raw hydrocarbon materials (or “feed”), using “multi-point feeding technology,” and injecting cooled catalyst downstream of the first reaction zone (3) as a “cold shock agent” to control the temperature of the second reaction zone (2). *Id.* ¶¶ 24, 101–02.

Independent claim 1 recites:

A method for circulating a cold regenerated catalyst, comprising:

¹ We cite the published '565 application: Patent Application Publication No. 2012/0298556. Appx. 210–24.

reacting hydrocarbon materials with a catalyst in a riser reactor to generate gas and oil products and a reacted catalyst, wherein the one riser reactor comprises only one reaction zone or at least two reaction zones;

separating the gas and oil products from the reacted catalyst in a settler,

stripping the separated catalyst in a stripping section;

burning and regenerating the stripped catalyst in a regenerator to obtain a hot regenerated catalyst;

cooling the hot regenerated catalyst by **a regenerated catalyst cooler** to form a cooled regenerated catalyst having a temperature in a range of 200°C to 720°C, for cycling use;

wherein when the one riser reactor comprises at least two reaction zones, **the one regenerated catalyst cooler is connected to the one riser reactor** and is used to adjust the reaction temperature of each of the reaction zones of the one riser reactor, so as to keep the reaction temperature of each of the reaction zones in an optimal value, respectively, or when the one riser reactor comprises only one reaction zone, **the one regenerated catalyst cooler is connected to the one riser reactor** and is used to adjust the reaction temperature of the only one reaction zone of the one riser reactor, so as to keep the reaction temperature in an optimal value.

Appx. 787 (emphases added); *Decision*, at *1.

Independent claim 13 recites the following limitation in addition to those in claim 1 (among other limitations not relevant here):

IN RE: LI

5

blending and buffering the cooled regenerated catalyst in ***a catalyst mixing buffer space being disposed in the downstream location of the regenerated catalyst cooler*** before the cooled regenerated catalyst entering the riser reactor;

Appx. 789–90 (emphasis added).

Independent claim 20 recites a similar limitation in addition to those in claim 1 (among other limitations not relevant here):

blending and buffering the cooled regenerated catalyst in ***the catalyst mixing buffer space being disposed underneath the heat-exchanging element*** before the cooled regenerated catalyst entering the riser reactor, wherein the catalyst mixing buffer space is independent and separate from spaces taken by the heat-exchanging element;

Appx. 791–92 (emphasis added).

Claim 6 (dependent on claim 1) recites in relevant part:

controlling the reaction temperature in the reaction zone of the riser reactor by adjusting a ratio of the cooled regenerated catalyst that enters the riser reactor and feed of the hydrocarbon materials that enter the riser reactor, adjusting the temperature of the cooled regenerated catalyst, using a multi-point feeding technology, adding a quenching agent to the riser reactor, or a combination thereof.

Appx. 788; *Decision*, at *5. Claims 16 and 22 (dependent on claims 13 and 20, respectively) are materially identical to claim 6. Appx 791, 793; *Decision*, at *5.

On December 24, 2021, the examiner issued a final rejection of all pending claims of the '565 application: claims

1–7, 10, 13–25, 27, 29, and 31–33. Appx. 159–60.² The examiner rejected all claims for obviousness under the applicable version of 35 U.S.C. § 103 (which, because of the asserted priority date, was the version that pre-dates the changes made by the Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011)). The examiner rejected all claims but claim 32 for obviousness over a single reference—Chinese Patent Publication No. 1664074A (“Li”), Appx. 700–62, which lists Li Li and Qunzhu Li as inventors—and rejected claim 32 for obviousness over Li plus another reference not at issue in this appeal.³ Appx. 163–66.

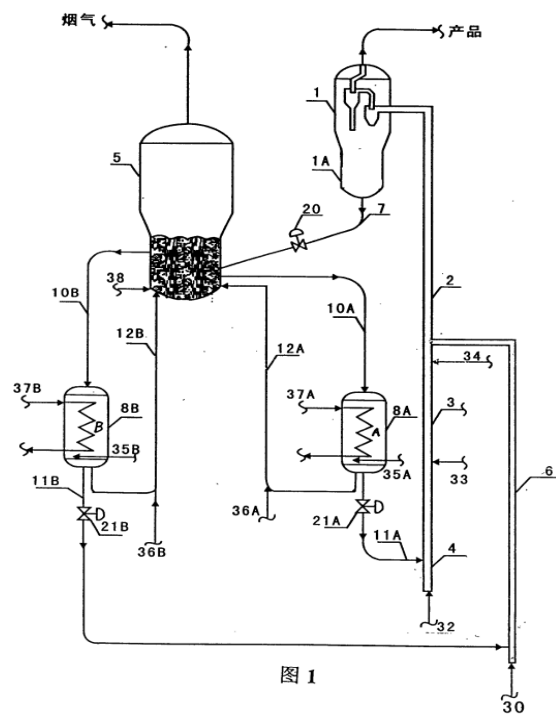
Li, like the ’565 application, describes methods for fluid catalytic cracking. Appx. 700. In the process described in Li, hydrocarbon materials react with a catalyst in a reactor with a first reaction zone (3) and a second reaction zone (2). Appx. 717. The reacted material flows into a settler (1), which separates the catalyst from the oil and gas. *Id.* The catalyst then flows into the regenerator (5) before entering one or more catalyst coolers (8A and 8B) prior to being recycled in the reactor. *Id.* at 717, 720. The structure used for the process is depicted in Figure 1 of Li, Appx. 759:

² Applicants assert that claims 32 and 33 were canceled “during the appeal to the Board,” Applicants Reply Br. at 14; *see also* Applicants Opening Br. at 27 n.2, whereas the PTO Director asserts that claims 32 and 33 were not canceled, PTO Response Br. at 12 n.4. The Board’s decision and listing of pending claims support the PTO’s view. *See Decision*, at *1; Appx. 787–95.

³ The other reference is U.S. Patent Application Publication No. 2010/0152515, but applicants do not separately address that reference and instead “rely solely on their arguments regarding . . . Li,” Applicants Opening Br. at 27 n.2.

IN RE: LI

7



The examiner found that Li teaches using one catalyst cooler (8A) with a plurality of outlets or multiple catalyst coolers (8A and 8B) for recycling the catalyst to the reactors and regenerator. Appx. 164 (citing Appx. 701–03). The examiner further found that Li describes a “mixing buffer space” for the cooled catalyst, as Li’s catalyst coolers (8A and 8B) have a lower portion in which a catalyst mixes with fluidized media for further cooling. Appx. 161–62, 164 (citing Appx. 717, 759–62). The examiner also found that Li discloses controlling the reaction-zone temperature by adjusting the ratio of hydrocarbon to oil, the amounts of cold and hot catalyst, and the temperature of the cold catalyst and by using multi-point feeding and cold-shock agents. Appx. 165 (citing Appx. 700–01, 704–05, 707, 716, 719).

On March 24, 2022, applicants appealed the examiner’s final rejection to the Board. They challenged the examiner’s determinations on three claim limitations

relevant here: (1) “a regenerated catalyst cooler,” recited in all pending claims; (2) “a catalyst mixing buffer space,” recited in independent claims 13 and 20 and dependent claims 14–19, 21–25, and 29–31; and (3) “controlling the reaction temperature in the reaction zone,” recited in dependent claims 6, 16, and 22.

After hearing a presentation from applicants’ counsel on April 25, 2023, Appx. 17–35, the Board affirmed the examiner’s decision on May 18, 2023. *Decision*, at *1. First, the Board rejected applicants’ argument that independent claims 1, 13, and 20 require that only one catalyst cooler be used to control the reaction temperature in one or two reaction zones, whereas Li discloses using two catalyst coolers, each to control the reaction temperature of a single reaction zone. *Id.* at *2–3. The Board emphasized that the at-issue claims use the open-ended term “comprising,” meaning that the claims do not exclude the use of an additional catalyst cooler, and it agreed with the examiner that Li itself teaches using a single catalyst cooler to adjust the reaction temperature of two reaction zones. *Id.* at *3. Second, the Board rejected applicants’ argument that the claimed catalyst mixing buffer space must be separate and independent from the catalyst cooler, explaining that the ’565 application does not define the term or require that a particular structure be used “other than it being a lower part of the catalyst cooler.” *Id.* at *3–4. Third, the Board rejected applicants’ argument that Li did not teach controlling the reaction temperature. *Id.* at *5. Finally, having determined that the examiner established a prima facie case of obviousness for the pending claims, the Board evaluated applicants’ evidence of objective indicia of nonobviousness and found it insufficient to alter the conclusion indicated by the prima facie case. *Id.* at *6–7 (citing *In re Kao*, 639 F.3d 1057, 1068 (Fed. Cir. 2011); *Newell Cos. v. Kenney Manufacturing Co.*, 864 F.2d 757, 768 (Fed. Cir. 1988)).

IN RE: LI

9

Applicants filed a request for rehearing, *see* 37 C.F.R. § 41.52, which the Board denied on October 4, 2023. Decision on Request for Rehearing at 1–13, *Ex parte Li*, No. 2023-000079 (P.T.A.B. Oct. 4, 2023), Appx. 226–38 (*Rehearing Decision*). Applicants timely appealed to this court on November 29, 2023, *see* 37 C.F.R. § 90.3(b)(1), and we have jurisdiction under 28 U.S.C. § 1295(a)(4)(A).

II

The ultimate determination on obviousness is a legal one made de novo on appeal, but it rests heavily on various underlying facts, on which we accept the Board’s findings if supported by substantial evidence. *In re Gartside*, 203 F.3d 1305, 1316 (Fed. Cir. 2000). As relevant here, what is disclosed by the prior art and whether particular objective indicia of nonobviousness exist are questions of fact. *See, e.g., Yita LLC v. MacNeil IP LLC*, 69 F.4th 1356, 1363 (Fed. Cir. 2023); *Randall Manufacturing v. Rea*, 733 F.3d 1355, 1362 (Fed. Cir. 2013); *In re Mouttet*, 686 F.3d 1322, 1330 (Fed. Cir. 2012); *Gartside*, 203 F.3d at 1319.

We decide issues of claim construction de novo, including all intrinsic-evidence matters and the significance to the proper construction of any findings on underlying facts, but we accept such findings if supported by substantial evidence. *See, e.g., Wasica Finance GmbH v. Control Automotive Systems, Inc.*, 853 F.3d 1272, 1278 (Fed. Cir. 2017). “A finding is supported by substantial evidence if a reasonable mind might accept the evidence as adequate to support the finding.” *Yita*, 69 F.4th at 1363 (citation omitted). “During examination, claims are to be given their broadest reasonable interpretation consistent with the specification, and claim language should be read in light of the specification as it would be interpreted by one of ordinary skill in the art.” *In re Montgomery*, 677 F.3d 1375, 1379 (Fed. Cir. 2012) (cleaned up) (citing *In re American Academy of Science Tech Center*, 367 F.3d 1359, 1364 (Fed. Cir. 2004)); *see*

also *In re Smith International, Inc.*, 871 F.3d 1375, 1381 (Fed. Cir. 2017).

Applicants challenge four aspects of the Board’s decision on appeal: (1) the Board’s construction of and finding that Li discloses “a regenerated catalyst cooler”; (2) the Board’s construction of and finding that Li discloses a “catalyst mixing buffer space”; (3) the Board’s finding that Li discloses controlling the reaction temperature in the reaction zone; and (4) the Board’s conclusion that applicants’ evidence of objective indicia of nonobviousness was not persuasive. We address and affirm each aspect of the Board’s decision in turn.

A

Applicants challenge the Board’s determinations regarding the required “regenerated catalyst cooler,” which is recited in each rejected claim, either expressly or through dependency. Applicants Opening Br. at 29–31, 47–59.

Because the independent claims recite “[a] method . . . comprising . . . a regenerated catalyst cooler,” the Board construed the claims as open-ended—requiring *at least* one catalyst cooler that performs the recited function of adjusting the reaction temperature in each of the reaction zones—and, in addition, it determined that the “regenerated catalyst cooler” limitation was made obvious by Li’s teaching of embodiments with one or more catalyst coolers. *Decision*, at *3. Applicants argue that the claims are not open-ended and should be read to require that only one catalyst cooler be used, so that the claims cannot be made obvious by prior art teaching use of multiple catalyst coolers connected to a single reaction zone. *See generally* Applicants Opening Br. at 29–31, 47–58.

We do not need to reach that claim-construction argument, however, because the Board reasonably found that Li itself discloses a process that uses only one catalyst

IN RE: LI

11

cooler to control the temperature of the reaction zone(s). The examiner found, and the Board agreed, that Li teaches “one catalyst cooler with a plurality of outlets for sending catalyst to each of the desired riser reactors and regenerator.” Appx. 164 (citing Appx. 701 (“The regenerator is provided with *one or more* inside or outside heat taking apparatuses, that is, catalyst coolers.” (emphasis added))); *Decision*, at *3. That determination is supported by substantial evidence. Li describes using two catalyst coolers (8A and 8B) to control the temperatures of the first and second reaction zones, respectively, but that catalyst cooler 8A “can be omitted.” Appx. 701–02. Figure 1 of Li supports the Board’s finding that Li’s catalyst cooler has a plurality of outlets for sending catalyst to each desired reactor and regenerator: The flow of cooled catalyst through the first reaction zone from catalyst cooler 8A “would also feed the catalyst to [second] reaction zone 2 . . . and adjust the temperature at some level within reaction zone 2.” *Decision*, at *3 (citing Appx. 759).

Thus, even if applicants are right about their claim-construction position on this claim limitation, which we need not decide, the Board’s finding that Li teaches this limitation must be affirmed.

B

Applicants challenge the Board’s determination regarding the “catalyst mixing buffer space” limitation of claims 13 and 20 and their dependent claims. Applicants Opening Br. at 59–66. The examiner found, and the Board agreed, that Li discloses a catalyst mixing buffer space because it discloses “the space in the catalyst cooler in which cooled catalyst and the fluidizing gas mix before leaving the cooler.” Appx. 164 (citing Appx. 717, 759–62); *Decision*, at *4. The Board’s finding rested on its construction of “catalyst mixing buffer space” to mean “a lower region of the catalyst cooler in which the catalyst is combined (mixed) with the fluidizing media and withdrawn from the cooler.”

Decision, at *4. Applicants challenge that construction, Applicants Opening Br. at 59–66, asserting that the catalyst mixing buffer space must be “independent and separate from the catalyst cooler,” *id.* at 63–64. This claim-construction argument is applicants’ sole challenge to the Board’s finding that Li discloses this claim limitation.

We reject applicants’ challenge to the claim construction. The claims do not require the proposed independence and separateness. Indeed, claim 20 suggests the absence of such a requirement when it recites “the catalyst mixing buffer space being disposed underneath the heat-exchanging element,” as the heat-exchanging element “is mounted *inside* the regenerated catalyst cooler.” Appx. 792 (emphasis added). The specification, moreover, repeatedly characterizes the mixing buffer space simply as being “in the lower part” of the catalyst cooler. *See, e.g.*, ’565 App. ¶ 86 (“Leaving the catalyst cooler 8A (the mixing buffer space in the lower part 9A)”); *id.* ¶ 84 (“The regenerator has two inside or outside taking-heat equipments as the catalyst coolers, including . . . the mixing buffer space in the lower part.”); *id.* ¶ 86 (“The regenerator 5 is connected with the catalyst cooler 8A through regenerator duct 10A and the regenerated catalyst after cooling enters into the mixing buffer space in the lower part.”). Each of the figures of the ’565 application indicates that the mixing buffer space is within the catalyst cooler, as reference numerals 9A and 9B point to locations within the catalyst coolers 8A and 8B. *See* ’565 App., figs. 1–4. With all the foregoing, we do not read a contrary requirement in language cited by applicants, *see* Applicants Opening Br. at 62, from ’565 App. ¶¶ 16–17, which refer to mixing buffer space as being “*in* the downstream” of the catalyst cooler (emphasis added)—not “downstream *of*” the catalyst cooler.

C

Applicants challenge the Board’s finding that Li teaches “controlling the reaction temperature in the

IN RE: LI

13

reaction zone of the riser reactor,” as required by dependent claims 6, 16, and 22. *See Decision*, at *5. Applicants argue that “Li uses only single-parameter adjustment of the catalyst-to-oil ratio” rather than “the combined control of the multi-parameters.” Applicants Opening Br. at 66. We see no reversible error in the Board’s finding on this limitation.

The Board found that “Li teaches controlling the reaction temperature in the reaction zones by using the cold regenerated catalyst, hot regenerated catalyst, cold shock agent 34, and the lifting medium 32.” *Decision*, at *5 (citing Appx. 718). The following disclosures in Li, among others cited by the Board, support this finding:

In order to conveniently control the temperature of the first reaction zone of the heavy oil riser reactor, provided can be a hot regenerated catalyst transporting pipe . . . that is directly connected to the pre-lifting zone 4 of the heavy oil riser reactor. . . . After the lifting mixing of the cold regenerated catalyst and the hot regenerated catalyst by a lifting medium 32 in the pre-lifting zone 4 of the heavy oil riser reactor, the temperature reaches equilibrium.

Appx. 718.

The injection point of a gaseous or liquid cold shock agent 34 may be upstream or downstream of the injection point of the cold catalyst . . . in order to conveniently control the temperatures of each of the reaction zones.

Appx. 720.

Given what the above-quoted disclosures are reasonably understood to mean, and because applicants do not cite to any particular disclosure within Li as supporting their argument, we do not discern any error in the Board’s decision as to claims 6, 16, and 22.

D

Finally, applicants challenge the Board’s analysis of their evidence of objective indicia of nonobviousness. Applicants Opening Br. at 40–46; *see Decision*, at *6–7; *Rehearing Decision*, at 6–10, Appx. 231–35. We agree with the Board that this evidence is insufficient to overcome the prima facie case of obviousness because it lacks nexus to what is “claimed and novel.” *See Kao*, 639 F.3d at 1068 (emphasis omitted).

Applicants submitted five declarations and “voluminous annexes,” *Decision*, at *6, to support their objective indicia arguments. *See* Appx. 239–699. Two of the declarations, as the Board noted, address “a claim that is not the same scope as the claim on appeal.” *Rehearing Decision*, at 6, Appx. 231 (citing Appx. 242–43 ¶ 10; Appx. 248–50 ¶ 10). Specifically, what the Zhang and Gao declarations refer to as “[c]laim 1 of the present application” does not actually correspond to the language of claim 1 before the Board. *Compare* Appx. 242–43 ¶ 10 *and* Appx. 248–50 ¶ 10, *with* Appx. 787. Rather, the listings in the Zhang and Gao declarations include various unclaimed limitations. Thus, the Board correctly reasoned that the declarations were insufficient to establish unexpected results and commercial success because they “do[] not reproduce the claim that is alleged to be the basis of unexpected result[s] and commercial success.” *Rehearing Decision*, at 6, Appx. 231. Applicants do not dispute the disparate-claims finding underlying that determination. *See* Applicants Opening Br. at 34–35, 41–42.

The three other declarations are from applicant Qunzhu Li. *See* Appx. 254–60 (January 2018); Appx. 261–64 (March 2018); Appx. 265–66 (August 2021). Applicants argue that these declarations, along with the annexes cited in them, demonstrate unexpected results, commercial success, long-felt but unmet need, and industry praise. Applicants Opening Br. at 40–46.

IN RE: LI

15

The Board rejected many of applicants' objective-indicia arguments resting on these declarations and annexes due to lack of nexus because, as discussed *supra* parts II.A–B, Li already disclosed the now-claimed invention (and specifically, the claimed catalyst cooler and mixing buffer space). *Decision*, at *6 (“Li teaches the limitations on which [applicants] rel[y] as critical or significant.”); *Rehearing Decision*, at 9, Appx. 234. “For objective evidence of secondary considerations to be accorded substantial weight, its proponent must establish a nexus between the evidence and the merits of the *claimed invention*. Where the offered secondary consideration actually results from something other than what is both claimed and *novel* in the claim, there is no nexus to the merits of the claimed invention.” *Kao*, 639 F.3d at 1068 (internal quotation marks and citations omitted). Because the features that applicants rely on to support their objective indicia arguments (the catalyst cooler and mixing buffer space) are recited in Li, the Board properly found no nexus between those features and any unexpected results, commercial success, long-felt but unmet need, or industry praise. *See Newell*, 864 F.2d at 768 (“[O]nce another supplied the key element, there was no long-felt need or, indeed, a problem to be solved.”); *In re Baxter Travenol Laboratories*, 952 F.2d 388, 392 (Fed. Cir. 1991) (“[W]hen unexpected results are used as evidence of nonobviousness, the results must be shown to be unexpected compared with the closest prior art.”).

The other objective-indicia arguments made by applicants relate to features not actually claimed (e.g., a catalyst-to-oil ratio of 8.6 and reactor temperature of 525°C). Applicants Opening Br. at 56–57; *Rehearing Decision*, at 8–9, Appx. 233–34 (“[T]he argued catalyst-to-oil ratio is not recited in claim 1.”). Such unclaimed features cannot establish objective indicia of nonobviousness of what is claimed. *See Kao*, 639 F.3d at 1068 (explaining that nexus must be established between the evidence and “the merits of the *claimed invention*”) (citation omitted). Because

sufficient nexus is a “fundamental requirement that must be met before secondary considerations can carry the day,” *see id.*, we discern no error in this aspect of the Board’s decision.

III

We have reviewed the remainder of applicants’ arguments and find them unpersuasive. We affirm the Board’s decision that all pending claims of the ’565 application are unpatentable for obviousness.

The parties shall bear their own costs.

AFFIRMED