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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/994,575	11/24/2010	Joachim Pfeffinger	074008-1093-US (286144)	4358

123223 7590 11/04/2016
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EXAMINER
BROOKS, CLINTON A

ART UNIT	PAPER NUMBER
1671	

NOTIFICATION DATE	DELIVERY MODE
11/04/2016	ELECTRONIC

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte JOACHIM PFEFFINGER[1]

Appeal 2014-006720
Application 12/994,575
Technology Center 1600

Before DONALD E. ADAMS, ERIC B. GRIMES, and JOHN G. NEW, *Administrative Patent Judges*.

GRIMES, *Administrative Patent Judge*.

DECISION ON APPEAL

This is an appeal under 35 U.S.C. § 134 involving claims to a process for hydrogenating organic compounds, which have been rejected as obvious. We have jurisdiction under 35 U.S.C. § 6(b).

We affirm.

STATEMENT OF THE CASE

"Catalytic hydrogenations of organic compounds are generally performed over heterogeneous catalysts, the catalyst frequently being arranged as a fixed bed." (Spec. 1:12–13.) This process "generally releases considerable amounts of heat" and requires devices for heat removal. (*Id*. at

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[1] Appellant identifies the Real Party in Interest as BASF SE. (Appeal Br. 2.)

1:14–16.) Using a stirred tank reactor instead of a fixed bed allows "high conversion . . . only in batchwise operation or, in continuous mode, virtually only at low volume flows," and heat removal remains a problem. (*Id.* at 3:3–7.) "The use of bubble column reactors which are provided with internals which restrict backmixing can prolong the residence time and hence increase the conversion in the process" but heat removal is limited. (*Id.* at 3:10–13.)

The Specification discloses a two-stage process for hydrogenating organic compounds, in which the first stage is carried out in a loop reactor with an external heat exchanger and the second stage is carried out in a bubble column reactor with limited backmixing. (*Id.* at 4:1–6.) The process also includes a polyphasic system in which "hydrogen constitutes the gas phase, while the organic compound is present in the liquid phase." (*Id.* at 4:9–10.)

Claims 21–32 are on appeal. Claim 21 is illustrative and reads as follows:

> 21. A continuous process for hydrogenating organic compounds in a polyphasic system in the presence of a homogeneous or heterogeneous catalyst, which comprises performing the process in two stages, the first stage being performed in a loop reactor with an external heat exchanger and the second stage in a bubble column reactor with limited backmixing.

The claims stand rejected as follows:

Claims 21–25 under 35 U.S.C. § 103(a) as obvious based on Sander[2] and Middleton[3] (Ans. 5) and

Claims 21–32 under 35 U.S.C. § 103(a) as obvious based on Bunnenberg,[4] Middleton, Henkel,[5] Zehner,[6] Ueyama,[7] and Schulz[8] (Ans. 7).

I

The Examiner has rejected claims 21–25 as obvious based on Sander and Middleton. The Examiner finds that Sander "teaches hydrogenation, a catalyst, loop reactor and bubble column and a reaction cascade in a continuous or batchwise manner." (Ans. 5.) The Examiner finds that Sander also teaches using heat exchangers in its process. (*Id.*)

The Examiner finds that Middleton teaches "the Buss loop reactor which contains a heat exchanger." (*Id.* at 7.) The Examiner concludes that it would have been obvious "to use an external heat exchanger on the loop

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[2] Sander et al., US 6,350,911 B1, Feb. 26, 2002.
[3] Middleton & Carpenter, *Stirred-Tank and Loop Reactors*, ULLMANN'S ENCYCLOPEDIA OF INDUSTRIAL CHEMISTRY (2005).
[4] Bunnenberg et al., DE 10119135 A1, Oct. 24, 2002. "Appellant[] refer[s] to U.S. Patent No. 6,504,060 as the English-language equivalent to Bunnenberg" (Appeal Br. 11), so we do as well.
[5] Henkel, *Reactor Types and Their Industrial Applications*, ULLMANN'S ENCYCLOPEDIA OF INDUSTRIAL CHEMISTRY (2005).
[6] Zehner & Kraume, *Bubble Columns*, ENCYCLOPEDIA OF INDUSTRIAL CHEMISTRY (2005).
[7] Ueyama et al., DE 19647126 A1, May 22, 1997. "Appellant[] refer[s] to . . . GB 2 307 191 A as the English-language equivalent to Ueyama." (Appeal Br. 11.)
[8] Schulz et al., EP 57364 A2, Aug. 11, 1982. "Appellant[] refer[s] to . . . U.S. Patent No. 4,436,702 as the English-language equivalent to Schulz." (Appeal Br. 11.)

reactor . . . because loop reactors are known in the art of hydrogenation . . . , and the Buss reactor having a heat exchanger externally is also known in the art. Thus, one skilled in the art would be combining known reactors for hydrogenation." (*Id.*)

We agree with the Examiner that the process of claim 21 would have been obvious based on Sander and Middleton. Sander discloses a process for continuous hydrogenation of nitro compounds in the presence of a catalyst.[9] (Sander 3:17–21.) Sander's process is carried out in a loop reactor. (*Id.* at 3:25–38, 51–52.) Sander discloses a preferred embodiment in which the reactor includes an internal heat exchanger (*id.* at 4:7–8) but also suggests "install[ing] a heat exchanger in the external loop flow in addition to the heat exchangers integrated in the reactor" (*id.* at 4:21–23). Finally, Sander discloses that hydrogenation of nitro compounds is conventionally carried out "batchwise in an autoclave or continuously in a loop reactor, a bubble column or a reactor cascade." (*Id.* at 1:21–23.)

Middleton discloses that "[t]he *Buss reactor* . . . is often used for hydrogenation. It has the advantage of rapid gas – liquid mass transfer in the initial reaction zone, combined with high heat removal capability in the tubular heat exchanger." (Middleton 7, right col.) Middleton's Figure 7 shows the Buss reactor with a heat exchanger external to the reaction tank. (*Id.*)

We agree with the Examiner that, based on these disclosures, it would have made obvious to use a loop reactor with an external heat exchanger in

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[9] As the Examiner notes (Ans. 5), a catalyst must be either homogeneous or heterogeneous.

Sander's process because (a) Sander expressly suggests doing do and (b) Middleton discloses that the Buss reactor, which includes an external heat exchanger, is often used for hydrogenation reactions. It would also have been obvious to use a two-stage system that includes a loop reactor and a bubble column reactor, because Sander discloses that hydrogenation of nitro compounds is conventionally carried out "continuously in a loop reactor, a bubble column *or a reactor cascade*." (Sander 1:21–23 (emphasis added).)

Appellant argues that neither of the references suggests using a loop reactor in a first stage and a bubble column reactor in a second stage. (Appeal Br. 8.)

This argument is unpersuasive, because Sander suggests using either a loop reactor, a bubble reactor, or a reactor cascade. Thus, Sander discloses using both of the types of reactor recited in claim 21 as well as using reactors in a cascade. Thus it would have been obvious to use a reactor cascade in which the first stage is a loop reactor and the second stage is a bubble reactor, because Sander teaches that both types of reactor are conventionally used for hydrogenation reactions.

Appellant also argues that Sander teaches not to use an external heat exchanger even though it suggests including an external heat exchanger in its system, because it "teaches to minimize the proportion of external loop flow." (Appeal Br. 9.)

Claim 21, however, does not require any particular level of flow through the external heat exchanger. Thus, Sander's suggestion to include one in its system, as well as Middleton's description of the Buss reactor as often used for hydrogenation reactions, would have made it obvious to

include an external heat exchanger in Sander's system, even if the flow through it was limited.

Appellant argues that he "surprisingly found that, by adding a second stage performed in a bubble column, there is a significant increase in the conversion of the starting material. Indeed, the specification provides that conversions of > 99.9% were obtained." (Appeal Br. 8–9.)

This argument is unpersuasive for two reasons. First, Appellant has pointed to no comparison to the closest prior art; in this case, Sander's examples showing use of a loop reactor alone. (*See* Sander 7:47 to 8:58.) Second, Sander states that "[t]he yield of aniline was, based on the mononitrobenzene employed, >99.5%." (*Id.* at 8:48–49.) Appellant's Specification also describes a two-stage prior art process comprising a stirred vessel and a bubble column reactor, as providing conversion rates of up to 99.1%. (Spec. 2:12–15.) Appellant has not provided a reasonable basis for concluding that the conversion rates shown in the Specification's examples are unexpectedly superior to those in prior art processes.

Finally, with respect to this rejection, Appellant argues that "there has been a long-felt but unsolved need for an efficient hydrogenation apparatus" and "if the present claims were indeed obvious in light of the prior art, Appellants [sic] submit that the claimed process would have been disclosed fully before the Appellant[] filed the present application." (Appeal Br. 10.)

This argument is also unpersuasive, because the prior art disclosed hydrogenation processes providing greater than 99% conversion efficiencies. Appellant has not provided evidence that those skilled in the art recognized a long-felt need for a still-more efficient process, or that skilled artisans would

have recognized 99.9% conversion to be a significant improvement on 99.1% or 99.5% conversion.

Claims 22–25 have not been argued separately and therefore fall with claim 21. 37 C.F.R. § 41.37(c)(1)(iv).

II

The Examiner has rejected claims 21–32 as obvious based on Bunnenberg, Middleton, Henkel, Zehner, Ueyama, and Schulz. The Examiner finds that Bunnenberg discloses hydrogenation in a reactor system that can include stirred tank reactors and bubble columns. (Ans. 7.) The Examiner concludes that it would have been obvious to include Middleton's loop reactor with an external heat exchanger in Bunnenberg's process because the combination amounts to using reactor types already known for hydrogenation. (*Id.*) The Examiner also reasons that all of the elements of claim 21 were known and the combination amounts to using them for their respective function to yield predictable results. (*Id.*) The Examiner cites the remaining references for their disclosures that "common reactor parts including perforated plates/trays, prevention of backmixing, segments and packing are known in the art." (*Id.*)

We agree with the Examiner that, based on these disclosures, it would have made obvious to use a loop reactor with an external heat exchanger in Bunnenberg's process. Bunnenberg discloses a continuous process of hydrogenating diaminodiphenylmethane in the presence of a catalyst. (Bunnenberg 1:7–10.) Bunnenberg states that "[i]t is particularly advantageous to use a cascade of two or more serially connected suspension reactors, for example, a cascade of stirred-tank reactors or a cascade of bubble-columns. Preference is given to using a cascade of two or more

serially connected suspension reactors." (*Id.* at 2:4–8.) Thus, Bunnenberg suggests using a cascade of two suspension reactors, for example, stirred tank reactors or bubble columns.

As discussed previously, Middleton discloses that a Buss reactor with an external heat exchanger is often used in hydrogenation reactions. Thus, it would have been obvious to combine a Buss reactor with a bubble column reactor in Bunnenberg's system because both types of reactors were known in the art for use in hydrogenation reactions and Bunnenberg does not limit its cascade of suspension reactors to reactors of the same type.

Appellant argues that "the cited combination fails to teach or suggest the combination of a loop reactor followed by a bubble column." (Appeal Br. 12.) For the reasons discussed above, however, we conclude that the cited references support a prima facie case that the process of claim 21 would have been obvious to a person of ordinary skill in the art.

Appellant also argues that "the claimed combination produces the unexpected result of superior conversion of the feedstock." (*Id.*)

This argument is unpersuasive. Bunnenberg states that its process results in "a conversion of MDA [starting material] of at least 95% . . . preferably at least 99%." (Bunnenberg 1:62–66.) Bunnenberg's working examples resulted in 0.1% starting material being left over after hydrogenation in either a single-stage or three-stage stirred tank reactor. (*See id.* at 4:41–55 (Table 2).) In other words, Bunnenberg's process resulted in 99.9% conversion of the starting material. Appellant's evidence is therefore unpersuasive of unexpectedly superior results.

Finally, Appellant argues that "the processes that are the subject matter of the present application and the cited references are of an

unpredictable nature. . . . Therefore, one of skill in the art would not have a reasonable expectation of success when combining the cited references." (Appeal Br. 12.)

This argument is also unpersuasive, because the evidence shows that both loop reactors with external heat exchangers (e.g., Buss reactors) and bubble column reactors were known in the art for use in carrying out hydrogenation reactions. Appellant has not pointed to evidence that using these known reactors for their known purpose in combination would not have predictably led to success in carrying out a hydrogenation reaction.

Claims 22–32 have not been argued separately and therefore fall with claim 21.[10] 37 C.F.R. § 41.37(c)(1)(iv).

SUMMARY

We affirm both of the rejections on appeal.

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).

AFFIRMED

[10] Although Appellant listed claim 24 and claim 32 under separate headings in the Appeal Brief, no substantive arguments were provided for either claim.