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Paper 48
Date: June 5, 2015

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

REG SYNTHETIC FUELS LLC,
Petitioner,

v.

NESTE OIL OYJ,
Patent Owner.

Case IPR2014-00192
Patent No. 8,278,492 B2

Before SHERIDAN K. SNEDDEN, CHRISTOPHER L. CRUMBLEY, and JON B. TORNQUIST, *Administrative Patent Judges.*

CRUMBLEY, *Administrative Patent Judge*.

FINAL WRITTEN DECISION
35 U.S.C. § 318 and 37 C.F.R. § 42.73

I. INTRODUCTION

On November 22, 2013, REG Synthetic Fuels, LLC ("REG")[1] filed a Petition requesting *inter partes* review of claims 1–24 of U.S. Patent No. 8,278,492 B2 (Ex. 1001, "the '492 patent"). Paper 5. REG subsequently filed an Amended Petition on December 13, 2013. Paper 16, "Pet." The owner of the '492 patent, Neste Oil Oyj ("Neste"), filed a Notice of Election on March 7, 2014, waiving a preliminary response. Paper 17. In a June 6, 2014, Decision on Institution of *Inter Partes* Review (Paper 18, "Dec."), we instituted trial on claims 1–24 based on the following grounds:

1. Whether claims 1–3, 5–21, 23 and 24 are unpatentable under 35 U.S.C. § 103(a) as having been obvious over Jakkula,[2] Monnier I,[3] and Gunstone;[4]

2. Whether claim 4 is unpatentable under 35 U.S.C. § 103(a) as having been obvious over Jakkula, Monnier I, Gunstone, and Toeneboehn;[5]

3. Whether claims 5, 6, 20, and 21 are unpatentable under 35 U.S.C. § 103(a) as having been obvious over Jakkula, Monnier I, Gunstone, and Oldřich;[6] and

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[1] The originally-named Petitioner in this case was Syntroleum Corporation. Pet. 1. On June 24, 2014, Petitioner filed updated Mandatory Notices informing the Board that REG had acquired Syntroleum Corporation. Paper 20. REG also informed the Board that it had filed with the Office a Power of Attorney for the '492 patent, retaining the same counsel that previously represented Syntroleum. *Id.* The Board updated the caption of this proceeding accordingly. For clarity, in this Decision we will refer to both Petitioner entities as "REG."

[2] Ex. 1004, EP Pub. App. 1396531 A2 (Mar. 10, 2004).

[3] Ex. 1005, U.S. Patent 5,705,722 (Jan. 6, 1998).

[4] Ex. 1006, Frank D. Gunstone et al., THE LIPID HANDBOOK (2d ed. 1994).

[5] Ex. 1007, U.S. Patent 5,298,639 (Mar. 29, 1994).

4. Whether claim 22 is unpatentable under 35 U.S.C. § 103(a) as having been obvious over Jakkula, Monnier I, Gunstone, and Monnier II.[7]

Dec. 16.

Following institution, Neste filed a Patent Owner Response to the Petition (Paper 26, "PO Resp."), and REG filed a Reply (Paper 31, "Pet. Reply"). Neste also filed a contingent Motion to Amend pursuant to 37 C.F.R. § 42.121 (Paper 25, "Mot."), to which REG filed an Opposition (Paper 30, "Mot. Opp."), and REG filed a Reply (Paper 34, "Mot. Reply").

REG supported its Petition with the Declaration of Dr. Edward L. Sughrue II (Ex. 1002, "first Sughrue Declaration"), and submitted a Second Declaration of Dr. Sughrue (Ex. 1043, "second Sughrue Declaration") with its Reply and Opposition to the Motion to Amend. Cross-examination of Dr. Sughrue was taken during two depositions. Exs. 2020, 2033.

With its Patent Owner Response and Motion to Amend, Neste filed the Declaration of Dr. Bruce C. Gates. Ex. 2001, "first Gates Declaration." Neste filed a Second Declaration of Dr. Gates with its Reply on its Motion to Amend (Ex. 2032, "second Gates Declaration"), and REG took the cross-examination of Dr. Gates during two depositions. Exs. 1065, 1079. REG

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[6] Ex. 1008, CZ Patent 283575 (Mar. 5, 1998). An English translation of Oldřich was submitted as Ex. 1009.

[7] Ex. 1013, U.S. Appln 08/269,090 (abandoned application to which Monnier I claims priority; pursuant to 37 C.F.R. § 1.14(a)(1)(iv), Monnier II became publicly available as of Monnier I's date of publication, Jan. 6, 1998).

filed a Motion for Observations Regarding Cross-Examination on Dr. Gates's second deposition (Paper 41), and REG filed a Response (Paper 43).

Oral hearing was requested by both parties and was held on February 9, 2015. A transcript of the oral hearing is included in the record. Paper 47, "Tr."

We have jurisdiction under 35 U.S.C. § 6(c). This Final Written Decision, issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73, addresses issues and arguments raised during trial. For the reasons discussed below, we determine that REG has met its burden to prove, by a preponderance of the evidence, that claims 1–24 of the '492 patent are *unpatentable*. We also determine that Neste has met its burden on its Motion to Amend regarding entry of proposed substitute claims 25–28, and thus, we *grant* the Motion to Amend.

A. The '492 Patent

The '492 patent is directed to a process for the manufacture of diesel range hydrocarbons from bio oils and fats, commonly called "biodiesel." Ex. 1001, Abstract; 1:6–14. In particular, the '492 patent discloses a two-step process in which a feed stream of biological origin, diluted with a hydrocarbon, is first hydrodeoxygenated, and then isomerized. *Id*. at 5:42–47. As the '492 patent notes, deoxygenation of a triglyceride, such as the ones found in bio-oil feedstocks, proceeds along one of two reaction pathways: deoxygenation through hydrogenolysis, which results in a hydrocarbon having the same number of carbon atoms as the fatty acid; and deoxygenation through decarboxylation or decarbonylation, which results in a hydrocarbon having one fewer carbon atom than the fatty acid feedstock. *Id.* at 2:51–58. The latter reaction pathways are depicted below:

$$\text{Decarboxylation}\; C_{17}H_{35}COOH \rightarrow C_{17}H_{36} + CO_2 \qquad \text{(A)}$$

$$\text{Decarbonylation}\; C_{17}H_{35}COOH + H_2 \rightarrow C_{17}H_{36} + CO + H_2O \qquad \text{(B1)}$$

$$C_{17}H_{35}COOH \rightarrow C_{17}H_{34} + CO + H_2O \qquad \text{(B2)}$$

Reaction pathway (A) depicts deoxygenation via decarboxylation, while reaction pathways (B1) and (B2) depict deoxygenation via decarbonylation. *Id.* at 3:1–5.

According to the ’492 patent, deoxygenation via hydrogenolysis requires a large amount of hydrogen, and releases a significant amount of heat that must be dissipated. *Id.* at 4:32–35. The inventors seek to avoid these problems by selectively favoring the decarboxylation/decarbonylation reaction pathways by “spiking” the feed stream with sulfur.[8] *Id.* at 8:36–45. The addition of 50–20000 w-ppm sulfur to the feed is said to result in significant reduction of hydrogen consumption, especially when the feed comprises C_{12}–C_{16} fatty acids. *Id.* at 5:63–6:5.

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[8] The ’492 patent refers to “sulphur.” We use the more common American English spelling of “sulfur,” but both spellings refer to the same element having the symbol S.

B. Illustrative Claims

Of the challenged claims, only claim 1 is independent, while claims 2–24 depend, directly or indirectly, from claim 1. Claim 1 is illustrative of the claimed subject matter of the ’492 patent and is reproduced as follows:

> 1. A process for the manufacture of diesel range hydrocarbons, wherein total feed comprising fresh feed is hydrotreated in a hydrotreating step to form a hydrotreated product, and the hydrotreated product is isomerised in an isomerisation step to form diesel range hydrocarbons, and wherein the fresh feed comprises at least 20% by weight of triglyceride C_{12}–C_{16} fatty acids, C_{12}–C_{16} fatty acid esters, C_{12}–C_{16} fatty acids, or combinations thereof,
>
> wherein at least one inorganic or organic sulphur compound or a refinery gas and/or liquid stream containing sulphur compounds is added to the total feed or fresh feed to give a total feed comprising 100–10,000 w-ppm sulphur calculated as elemental sulphur,
>
> wherein during the hydrotreating step, the pressure is in the range of 2–15 MPa, and the temperature is between 200 and 400° C., and
>
> wherein during the isomerisation step, the pressure is in the range of 2–15 MPa, and the temperature is between 200 and 500° C.

Ex. 1001, 15:2–21.

In its Motion to Amend, Neste proposed substitute claims 25–28, of which claim 25 is independent and a substitute for claim 1, if found unpatentable. Claims 26–28 are proposed as substitutes for dependent claims 14, 16, and 17, respectively. Proposed claim 25 reads as follows, with underlined material indicating language added to, and brackets indicating language removed from, original claim 1:

> 25. A process for the manufacture of diesel range hydrocarbons, wherein total feed comprising fresh feed is hydrotreated in a hydrotreating step to form a hydrotreated product, and the hydrotreated product is isomerised in an isomerisation step to form diesel range hydrocarbons, and wherein the fresh feed is of biological origin and comprises at least [[20]] 40% by weight of triglyceride C_{12}–C_{16} fatty acids, C_{12}–C_{16} fatty acid esters, C_{12}–C_{16} fatty acids, or combinations thereof,
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> wherein at least one inorganic or organic sulphur compound or a refinery gas and/or liquid stream containing sulphur compounds is added to the total feed or fresh feed to give a total feed comprising [100-10,000] 5,000-8,000 w-ppm sulphur calculated as elemental sulphur,
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> wherein the total feed comprises fresh feed and additionally at least one diluting agent, and the diluting agent is selected from hydrocarbons and recycled products of the process or mixtures thereof and the diluting agent/fresh feed-ratio is 5-30:1,
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> wherein an isomerisation catalyst comprising a metal selected from Pt and Pd is used in the isomerisation step,
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> wherein during the hydrotreating step, the pressure is in the range of 2–15 MPa, and the temperature is between 200 and 400° C., and
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> wherein during the isomerisation step, the pressure is in the range of 2–15 MPa, and the temperature is between 200 and 500° C.

Mot. 1–2.

II. DISCUSSION

A. Claim Construction

For purposes of our Decision to Institute, we analyzed each claim term in light of its broadest reasonable interpretation, as understood by one of ordinary skill in the art and as consistent with the specification of the ’492 patent, and determined that resolution of the issues presented in the Petition did not require explicit construction of any claim terms. Dec. 6–7 (citing 37 C.F.R. § 42.100(b)); *see also In re Cuozzo Speed Techs., LLC*, 778 F.3d 1271, 1281–82 (Fed. Cir. 2015) (“Congress implicitly adopted the broadest reasonable interpretation standard in enacting the AIA,” and “the standard was properly adopted by PTO regulation.”).

As discussed below, the parties’ dispute during trial focused on whether a person of ordinary skill in the art would have had reason to combine the prior art references, not on the presence or absence of any particular claim element or the particular construction thereof. Nor do Neste’s proposed substitute claims introduce new terminology that requires construction. No explicit constructions are required, therefore, in order to resolve the issues pending before the Board. *See Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) (“[O]nly those terms need be construed that are in controversy, and only to the extent necessary to resolve the controversy.”).

B. Patentability of Original Claims 1–24

In our Decision to Institute, we found persuasive REG's analysis of how the elements of claims 1–24 are taught by the disclosures of Jakkula, Monnier I, Gunstone, and the other various secondary references. Dec. 9. Neste's Response does not address this analysis of the claim elements, but rather focuses on whether a person of ordinary skill in the art would have had reason to combine the disclosures of Jakkula and Monnier I. PO Resp. 20. At oral argument, both parties agreed that there is no dispute that the individual components of the challenged claims were known in the art. Tr. 6, 22. On this basis, we reconfirm our findings from the Decision to Institute, and conclude that REG has established, by a preponderance of the evidence, that each element of challenged claims 1–24 is taught by the cited prior art.

We, therefore, turn to the question of whether REG has articulated sufficient reason to combine Jakkula and Monnier I.

1. Proposed Reason to Combine the References

Jakkula discloses a process for converting a biological starting material such as vegetable oil or animal fat into a hydrocarbon suitable for use as diesel fuel. Ex. 1004 ¶¶ 1, 13. The process comprises two steps: a hydrodeoxygenation (HDO) step followed by a hydroisomerization (HI) step. *Id.* ¶ 16. HDO is performed using a nickel-molybdenum on alumina catalyst at a pressure between 20–150 bar and a temperature between 200–500 ºC. *Id.* ¶ 20. In the second HI step, Jakkula discloses using, for example, a platinum or palladium catalyst at a pressure of 20–150 bar and a temperature of 200–500 ºC. *Id.* ¶¶ 30–31.

Monnier I discloses an HDO process that, like Jakkula, hydrotreats a biological feedstock using a nickel-molybdenum on alumina catalyst. Ex. 1005, 3:61–64. Monnier I teaches presulfiding the catalyst, and then spiking the feed stream with 1000 w-ppm sulfur to "avoid loss of sulphided active sites on the catalyst surface and maintain catalyst activity." *Id.* at 4:1–18.

REG argues that Jakkula and Monnier I disclose "essentially identical" processes. Pet. 14. Given Monnier I's disclosure that a sulfur spike can avoid a loss of catalyst activity, REG contends that a person of ordinary skill in the art would have had reason to modify the process of Jakkula using the sulfur spike taught in Monnier I. *Id.* Dr. Sughrue supports this rationale, testifying that "[t]ypical hydrotreatment catalysts need to be in a sulfide state to remain active," and that due to the low sulfur content of bio-based feedstocks, it was known that sulfur should be added to the feedstock to keep the catalyst in its sulfided state. Ex. 1002 ¶ 59. Dr. Sughrue cites Monnier I, as well as Laurent II,[9] as supporting this knowledge in the art. *Id.* ¶¶ 60–63.

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[9] Ex. 1011, Etienne Laurent & Bernard Delmon, *Study of the Hydrodeoxygenation of Carbonyl, Carboxylic and Guaiacyl Groups Over Sulfide CoMo/γ-Al_2O_3 and NiMo/γ-Al_2O_3 Catalyst. II. Influence of Water, Ammonia and Hydrogen Sulfide*, 109 Applied Catalysis A: General 97, 99 (1994) ("Laurent II") ("if sulfided catalysts are going to be used for . . . hydrotreatment, it is generally accepted that a source of sulfur . . . will be required for keeping the sulfide phases active over long periods.")

Dr. Sughrue provides an additional rationale for combining the processes of Jakkula and Monnier I, testifying that the prior art recognized that the presence of sulfur in a feedstock promotes decarboxylation during HDO reactions, leading to decreased hydrogen consumption. *Id.* ¶ 49. Laurent II, for example, discloses that "[t]he presence of hydrogen sulfide, whatever the amount, causes an increase of the selectivity towards decarboxylated products." Ex. 1011, 107. Dr. Sughrue testifies that Table 4 of Laurent II discloses that between 2000 w-ppm and 7900 w-ppm sulfur resulted in decarboxylation selectivity of 44–57%, depending on the catalyst used. Ex. 1002 ¶ 53. In a similar vein, Dr. Sughrue cites Ferrari,[10] which tested sulfur concentrations between 1266 w-ppm and 18,992 w-ppm, and concluded that the highest selectivity for decarboxylation was found at 4431 w-ppm sulfur. *Id.* ¶¶ 54–57 (citing Ex. 1012, 90, Fig. 5).

2. *Whether the Prior Art Teaches Away from Adding Sulfur*

In response, Neste focuses on a distinction between the processes disclosed in Jakkula and Monnier I (as well as the other prior art suggesting the desirability of a sulfur spike): whereas Monnier I and the other references pertain to HDO processes alone, Jakkula discloses an HDO step followed by an HI step. PO Resp. 21–22. According to Neste, Jakkula in fact "teaches away from adding sulfur to the feed in a hydrotreating process

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[10] Ex. 1012, M. Ferrari et al., *Influence of the Hydrogen Sulfide Partial Pressure on the Hydrodeoxygenation Reactions Over Sulfided CoMo/Carbon Catalysts*, 1999 Hydrotreatment & Hydrocracking Oil Fractions 85 (B. Delmon et al. eds.).

when the product of that process is fed to a downstream hydroisomerization process carried out with a noble metal-containing catalyst." *Id.* at 21.

"[W]hen the prior art teaches away from combining certain known elements, discovery of a successful means of combining them is more likely to be nonobvious." *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 416 (2007). A reference teaches away if it would discourage a person of ordinary skill in the art from following the path set out in the reference, or lead in a direction divergent from the path that was taken by the applicant. *In re Gurley*, 27 F.3d 551, 553 (Fed. Cir. 1994). "[I]n weighing the suggestive power of each reference, [we] must consider the degree to which one reference might accurately discredit another." *In re Young*, 927 F.2d 588, 591 (Fed. Cir. 1991).

Neste analogizes the case at hand to the one addressed by the Supreme Court in *United States v. Adams*, 383 U.S. 39 (1966). PO Resp. 39. In *Adams*, the prior art disclosed the use of zinc anodes in batteries, and also suggested the substitution of magnesium for zinc. 383 U.S. at 46. Despite these teachings, the Court found that the claimed water-activated battery—which used a magnesium anode—was nonobvious. *Id.* at 51. The Court noted that the prior art taught that water-activated batteries "were successful only when combined with electrolytes detrimental to the use of magnesium," and therefore a person of ordinary skill in the art would have been deterred from using magnesium in a water-activated battery. *Id.* at 52.

In the present case, Jakkula discloses that "nitrogen, sulphur and phosphorus . . . are known catalyst poisons and inhibitors inevitably reducing the service life of the catalyst and necessitating frequent regenerations thereof." Ex. 1004 ¶ 6. Jakkula characterizes its HI catalyst as "very expensive and extremely sensitive to catalyst poisons," and thus emphasizes "protection of the isomerization catalyst." *Id.* ¶¶ 10, 64. As an optional embodiment, Jakkula proposes purifying the product of the HDO step using a stripping step, to remove impurities as completely as possible prior to the HI step. *Id.* ¶ 26.

Neste argues, therefore, that Jakkula explicitly discourages the use of sulfur in its two-step process. PO Resp. 23. In addition, Neste points out that each of the prior art references cited by REG as disclosing the addition of sulfur are one-step HDO processes, which are not followed by an HI step. *Id.* at 33. As such, these references are not faced with the need to protect the expensive HI catalyst from poisons.

Neste's declarant, Dr. Gates, testifies that the prior art recognized that HI catalysts were extremely sensitive to poisoning by sulfur. Ex. 2001 ¶¶ 42–49. York,[11] for example, is cited as warning against exposing platinum catalysts to as little as 30 w-ppm sulfur. Ex. 2013, 676, Fig. 8.

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[11] Ex. 2013, Andrew P. E. York, et al., *Comparative Effect of Organosulfur Compounds on Catalysts for the n-Heptane Isomerization Reaction at Medium Pressure: Mo_2C-Oxygen-Modified, MoO_3-Carbon-Modified, Pt/γ-Al_2O_3, and Pt/β-Zeolite Catalysts*, 35 INDUS. & ENG'G CHEMISTRY RES. 672–82 (1996).

Biswas[12] notes that "[s]ulfur contents of less than 1 ppm are commonly required," because the presence of sulfur reduces the expected life of Pt/Al_2O_3 catalysts. Ex. 2007, 234.

For these reasons, Neste argues, a person of ordinary skill in the art would have understood that any sulfur added to the HDO step of Jakkula would need to be removed prior to the HI step. PO Resp. 25. As such, adding sulfur would "add risk" to Jakkula's process, thereby discouraging the skilled artisan given the "several million dollar" expense of replacing a poisoned HI catalyst. *Id*. at 25, 37.

Dr. Sughrue responds by arguing that Dr. Gates's testimony focuses on particularly sensitive catalysts, and ignores that, at the time of the invention, there were catalysts known to be more tolerant of sulfur. Ex. 1043 ¶¶ 34–53. REG argues that other references disclose HI catalysts that do not exhibit detrimental effects when exposed to sulfur, such as Raulo[13] (1000 w-ppm sulfur) and Prada[14] (10,000 w-ppm sulfur). Pet. Reply 3.

REG also contends that, even if HI catalysts could not tolerate high levels of sulfur, HDO processes were known at the time of invention that reduced the level of sulfur to below 10 w-ppm. *Id*. at 10. Alternatively, REG argues, purification steps could be included between the HDO and HI

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[12] Ex. 2007, J. Biswas, et al., *The Role of Deposited Poisons and Crystallite Surface Structure in the Activity and Selectivity of Reforming Catalysts*, 30(2) CATALYSIS REVIEWS: SCI. & ENG'G 161–247 (1988).
[13] Ex. 1023, U.S. Patent 6,399,845 B1 (June 4, 2002).
[14] Ex. 1059, U.S. Patent 5,612,273 (Mar. 18, 1997).

steps of Jakkula to remove sulfur if HI catalyst poisoning was a concern. *Id.* at 10–11. Indeed, Jakkula itself discloses an optional stripping step, in order to reduce the level of sulfur in the stream prior to the HI step. Ex. 1004 ¶ 26.

3. Conclusion

We conclude that the evidence of record establishes that a person of ordinary skill in the art would have had reason to combine Jakkula and Monnier I, and would not have been discouraged from doing so. Monnier I and Laurent II disclose that spiking a biological feedstock with sulfur prevents loss of HDO catalyst activity. Ex. 1005, 4:1–18; Ex. 1011, 99. Furthermore, we find that the prior art recognized an additional advantage of adding sulfur to an HDO feedstock, namely increased selectivity of the decarboxylation reaction pathway and consequent reduction of hydrogen consumption. Ex. 1011, 107; Ex. 1012, 90, Fig. 5. Notably, this is the same benefit of added sulfur recognized by the ’492 patent. Ex. 1001, 8:36–45.

In addition, Laurent II discloses that maximum decarboxylation selectivity was reached at an H_2S concentration of 49 mmol/L, which Dr. Sughrue credibly testifies corresponds to approximately 2000 w-ppm. Ex. 1011, 107, Table 4; Ex. 1002 ¶ 52. Similarly, Ferrari discloses that decarboxylation selectivity reaches a maximum at approximately 35 kPa H_2S partial pressure, which converts to 4431 w-ppm sulfur according to Dr. Sughrue. Ex. 1012, 90, Fig. 5; Ex. 1002 ¶¶ 55–56. Indeed, Dr. Sughrue and Dr. Gates agree on this point. Ex. 2001 ¶ 94; Ex. 1002 ¶¶ 56–57 (Sughrue:

"The decarboxylation selectivity as measured by Ferrari increased . . . to at least about 32–33% at 35 kPa H_2S (4431 wppm sulfur) . . . . [A]s the hydrogen sulfide partial pressure increases beyond these values, the selectivity for decarboxylation decreases from the maxima."). In view of these disclosures, a person of ordinary skill in the art would have had reason to add between 2000–4431 w-ppm sulfur to the HDO feedstock of Jakkula, within the ranges of dependent claims 7 (1000–8000 w-ppm) and 22 (2000–5000 w-ppm).

We are not convinced by Neste's arguments that Jakkula, or the prior art in general, teaches away from the use of sulfur. We find that HI catalysts capable of tolerating high sulfur levels, including up to 10,000 w-ppm, were known in the art at the time of the invention. Ex. 1059, 7:36–43. Alternatively, if using an HI catalyst that was not sulfur-tolerant, a person of ordinary skill in the art would have known that a purification step, such as the stripping step disclosed by Jakkula, could be used between the HDO and HI processes. Ex. 1004 ¶ 26.

Aside from these findings, we also note that Neste's arguments regarding teaching away may best be characterized as economic ones. In other words, Neste argues that a person of ordinary skill in the art would have recognized that the use of sulfur, even at the low levels that can be obtained via stripping, decreases the life expectancy of the HI catalyst over the long term. PO Resp. 27, 38–39. Because of the high cost of replacing an HI catalyst, therefore, Neste concludes that the skilled artisan would have avoided the addition of sulfur entirely. *Id.* Such economic concerns, however, are not sufficient bases for a conclusion of teaching away. *See Orthopedic Equip. Co., Inc. v. United States*, 702 F.2d 1005, 1013 (Fed. Cir. 1983). As stated by the Federal Circuit:

> The combination of these two inventions does not make good economic sense, but there is no mismatch between their technologies. . . . [T]he fact that the two disclosed apparatus would not be combined by businessmen for economic reasons is not the same as saying that it could not be done because skilled persons in the art felt that there was some technological incompatibility that prevented their combination. Only the latter fact is telling on the issue of nonobviousness.

Id.

In other words, we recognize that engineering necessarily involves design choices, which may increase the costs of performing a process. If a modification, however, leads to some increase in functionality or yield—such as increased decarboxylation selectivity and resultant decreased hydrogen consumption—a skilled artisan may consider the increased costs to be justified. The fact that the use of added sulfur may result in higher costs of HI catalyst over the long run is not sufficient reason to conclude that a person of ordinary skill in the art would have been discouraged from adding sulfur.

For the foregoing reasons, REG has proven by a preponderance of the evidence that the prior art teaches all elements of challenged claims 1–24, and that a person of ordinary skill in the art would have had reason to combine the disclosures. Furthermore, we conclude that such a combination would have been within the level of ordinary skill in the art, as evidenced by the prior art of record. We, therefore, conclude that claims 1–24 would have been obvious at the time of the invention, and thus are unpatentable under 35 U.S.C. § 103.

C. Patentability of Proposed Substitute Claims

In an *inter partes* review, amended claims are not added to the patent as of right, but rather must be proposed as a part of a motion to amend. 35 U.S.C. § 316(d). As moving party, the patent owner bears the burden of proof to establish that it is entitled to the relief requested; namely, addition of the proposed claims to the patent. 37 C.F.R. § 42.20(c). A patent owner must meet the requirements of 37 C.F.R. § 42.121, and demonstrate the patentability of the proposed substitute claims.

The parties do not dispute that Neste has satisfied the requirements of 37 C.F.R. § 42.121, including: 1) the amendment is responsive to a ground of unpatentability; 2) the amendment does not enlarge the scope of the claims or introduce new matter; 3) the Motion proposes a reasonable number of substitute claims; and 4) the Motion sets forth the support for the proposed claims in the original disclosure. Based on our review of the Motion, we agree that these requirements have been met.

Regarding the patentability of the proposed substitute claims, the amendments do not introduce new terminology that requires construction. *See Idle Free Systems, Inc. v. Bergstrom, Inc.*, Case IPR2012-00027, slip op. at 7 (PTAB June 11, 2013) (Paper 26, "*Idle Free*") (informative). Proposed claim 25 is a substitute for original claim 1 and incorporates claim 1's limitations, as well as the limitations of original dependent claims 6, 10, 18, and 18. The claim also adds a new limitation not found in the original claims, that the total feed comprises 5000–8000 w-ppm sulfur. Mot. 2.

We, therefore, turn to the question of whether Neste has met its burden of proof to establish that claims 25–28 are patentable. While not required to prove that the claims are patentable over every item of prior art known to a person of ordinary skill, Neste is required to explain why the claims are patentable over the prior art of record. *Idle Free*, slip op. at 7. In addition, Neste's duty of candor to the Office requires that it discuss any relevant prior art not of record but known to it. *See* 37 C.F.R. § 42.11; *Idle Free*, slip op. at 7.

REG argues that the Motion should be denied, as it allegedly fails to address all relevant prior art known to Neste. Mot. Opp. 2 (citing *ScentAir Tech., Inc. v. Prolitec, Inc*., Case IPR2013-00179, slip. op. at 27–30 (PTAB June 26, 2014) (Paper 60, "*ScentAir*")). REG identifies three references in particular: Raulo and Prada, both of which were discussed above in section II.B.2, and Plantenga.[15] *Id.* at 3–5. REG identifies the first two references' disclosure of sulfur-tolerant HI catalysts as being relevant to the patentability of proposed claim 25. Plantenga is cited as disclosing a process that can reduce sulfur in a feedstock from 12,000 w-ppm to near 6 w-ppm.

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[15] Ex. 1064, F. L. Plantenga, et al., *"NEBULA": A Hydroprocessing Catalyst with Breakthrough Activity*, 145 STUDIES IN SURFACE SCI. & CATALYSIS 407–410 (2003).

In *ScentAir*, the record established that Patent Owner was aware of at least one reference which disclosed the precise limitation that was added to the proposed substitute claim to distinguish it from the prior art. *See ScentAir*, slip op. at 30. In addition, the panel in *ScentAir* noted that Patent Owner's Motion to Amend expressly stated that prior to the challenged patent, "no one had invented" a product having the newly added limitation, a statement directly contradicted by the prior art of which Patent Owner was aware. *Id*. at 28. In the case at hand, however, the three references cited by REG are relevant to Neste's teaching away argument, not any issue newly raised by the Motion to Amend. As Neste points out, REG does not allege that any of the proposed substitute claims are unpatentable over a combination of references that includes Raulo, Prada, or Plantenga. We consider the present case to be distinguishable from that of *ScentAir*, and decline to deny the Motion for failing to address all relevant prior art.

1. Neste's Arguments that Claim 25 is Patentable

Neste concedes that the individual elements of claim 25 were known in the art. Mot. 12. Nevertheless, the claim as a whole is said to be patentable because, according to Neste, the combination of those elements would have run counter to prevailing wisdom in the art at the time of the invention. *Id*. Dr. Gates testifies to the following: the use of sulfur is not required for HDO processes (Ex. 2001 ¶ 18); that even if purified, the result of a sulfided HDO process would necessarily contain some sulfur (*id.* ¶¶ 50–51); and low levels of sulfur cause deactivation of HI catalysts, which are expensive and require plant downtime to replace (*id.* ¶¶ 42–49). These arguments, however, do not distinguish the proposed substitute claims over the prior art, for the same reasons that they do not distinguish the original claims over the prior art.

Neste also directs our attention to the new limitation added to claim 25, which requires 5000–8000 w-ppm sulfur. Mot. 13. Neste contends that this limitation distinguishes over the known prior art, even if the art can be said to suggest the use of a sulfided feedstock in a process comprising both an HDO and HI step. *Id.* Dr. Gates testifies that a person of ordinary skill "would have been aware of the need to limit a hydroisomerization catalyst's exposure to sulfur, and would not have chosen to add more sulfur than was necessary and then incur a large expense to go back and remove it." Ex. 2032 ¶ 74.

Neste addresses the two rationales for modifying Jakkula set forth in the Petition. First, Monnier I and Monnier II disclose the addition of sulfur to biological feedstocks to maintain the HDO catalyst in a sulfide state. According to Monnier I, 1000 w-ppm sulfur is sufficient to avoid loss of sulfided catalyst. Ex. 1005, 4:14–17. Monnier II discloses a broader range of 200–3000 w-ppm sulfur, but as Neste notes, the reference does not disclose any advantage to using more than 1000 w-ppm sulfur. Ex. 1013, 5. Neste asserts that even if motivated by the Monnier references to add sulfur to the process of Jakkula, a skilled artisan would have used the minimum amount of sulfur necessary to achieve the benefits disclosed in Monnier, namely 1000 w-ppm. Mot. 13.

REG does not seriously contest Neste's arguments regarding the Monnier references, or assert that they would have provided reason to add 5000–8000 w-ppm sulfur to the process of Jakkula. Rather, the parties' dispute during trial focused on the Laurent and Ferrari references, which are discussed below.

Ferrari

Ferrari reports the results of experiments studying the effect of varying concentrations of sulfur on HDO catalyst activity. Ex. 1012, 86. In particular, Table 3 and Figure 5 of Ferrari report the effect of hydrogen sulfide partial pressure (sulfur concentration) on decarboxylation selectivity. *Id*. at 90–91. Dr. Gates testifies that Ferrari discloses a maximum decarboxylation selectivity of approximately 32% at 35 kPa partial pressure, which Dr. Sughrue converts to 4431 w-ppm sulfur. Ex. 2001 ¶ 94 (citing Ex. 1002 ¶ 56). After this point, Ferrari reports that decarboxylation selectivity decreases with increasing sulfur concentration. Ex. 1012, Fig. 5. Neste argues that a person of ordinary skill in the art would have had no reason to use 5000–8000 w-ppm sulfur in the process of Jakkula, given that Ferrari reports that such a concentration would lead to decreased decarboxylation selectivity. Mot. 15.

REG characterizes Ferrari as disclosing that the highest selectivity for decarboxylation occurs "near 5,000 ppm sulfur." Mot. Opp. 8. Dr. Sughrue concedes, however, that beyond about 4431 w-ppm sulfur, "the selectivity for decarboxylation decreases from the maxima." Ex. 1002 ¶ 57. The claimed range of 5000–8000 w-ppm is characterized by Dr. Sughrue as "a prime range for investigation." Ex. 1043 ¶ 130. Neither Dr. Sughrue nor REG explain why this is so; it is not clear why the skilled artisan, seeking to increase decarboxylation selectivity, would have "investigated" a range of sulfur concentration already reported by Ferrari to lead to decreased selectivity. On this record, we find sufficient evidence to conclude that a person of ordinary skill would not have been motivated by Ferrari to use a sulfur concentration of 5000–8000 w-ppm sulfur.

Laurent I

Neste argues that the Laurent references—Laurent I[16] and Laurent II—have limited real-world applicability, as they studied the effects of sulfur on model compounds rather than actual feedstocks. Mot. 13–14. Dr. Gates testifies that Laurent I, though acknowledging the benefit of decarboxylation selectivity, does not give any reason to select a sulfur concentration between 5000 and 8000 w-ppm. Ex. 2032 ¶ 20. This is due to the fact that, as Dr. Sughrue calculates, all reactions of Laurent I were run using approximately 2000 w-ppm sulfur. Ex. 1002 ¶ 50.

Notwithstanding this fact, REG argues that Laurent I would have given a person of ordinary skill in the art motivation to "test and optimize the level of sulfur for a given biological feedstock" because of the disclosed benefits of decarboxylation selectivity. Mot. Opp. 8. In particular, Laurent I

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[16] Ex. 1010, Etienne Laurent & Bernard Delmon, *Study of the Hydrodeoxygenation of Carbonyl, Carboxylic and Guaiacyl Groups over Sulfided CoMo/γ-Al_2O_3 and NiMo/γ-Al_2O_3 Catalysts. I. Catalytic Reaction Schemes*, 109 Applied Catalysis A 77–96 (1994).

discloses that increased decarboxylation results in relatively low hydrogen consumption, limiting the cost of the refining operation. Ex. 1010, 78. Dr. Sughrue testifies that optimization of the sulfur concentration would have been within the level of ordinary skill in the art exemplified by the Laurent and Ferrari references. Ex. 1002 ¶ 126.

"[W]here the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation." *In re Aller*, 220 F.2d 454, 456 (CCPA 1955). In order for routine optimization of reaction conditions to be considered obvious, however, the art must first recognize that the conditions are result-effective variables. *In re Antonie*, 559 F.2d 618, 620 (CCPA 1977). In the case at hand, we do not find that Laurent I discloses that sulfur concentration is a result-effective variable leading to increased decarboxylation selectivity. Indeed, Laurent I does not recognize sulfur concentration as a variable at all; as Dr. Sughrue acknowledges, all reactions were run using the same concentration of approximately 2000 w-ppm sulfur. Ex. 1010, 81, Table 1; Ex. 1002 ¶ 50.

Even if it were disclosed to be a result-effective variable, we do not find that increasing the sulfur concentration from 2000 w-ppm to 5000–8000 w-ppm—2.5 to 4 times that disclosed—would have been considered "routine optimization" at the time of the invention. As discussed above, although such an increase in concentration would have been considered technologically feasible by one of ordinary skill, the prior art reflects practical and economic considerations that would have counseled against increasing sulfur concentration beyond what was necessary to achieve beneficial effects. In our view, more than doubling the concentration of sulfur when faced with these considerations would not have been "routine."

Laurent II

Neste argues that while Laurent II generally states that "hydrogen sulfide, whatever the amount, causes an increase of the selectivity towards decarboxylated products," the reference does not provide a reason to add 5000–8000 w-ppm sulfur to a feedstock. Mot. 14. In particular, Neste points to Table 4 of Laurent II, which discloses that maximum decarboxylation selectivity is reached at about 2000 w-ppm sulfur. *Id.* (citing Ex. 1011, 107). A person of ordinary skill, it is argued, would have had no reason to use more than 2000 w-ppm sulfur, based on these results. *Id.*

REG contends that because Laurent II reports maximum decarboxylation selectivity in the range of 2000–7900 w-ppm sulfur, a person of ordinary skill in the art would have had reason to "test and explore" sulfur levels within this range to find the optimal level. Mot. Opp. 10–11. This, in combination with the disclosure of Jakkula, would have resulted in a process using the claimed 5000–8000 w-ppm sulfur. *Id.*

Again, we fail to find REG's routine optimization argument persuasive. In contrast to Laurent I, Laurent II does disclose that sulfur concentration is a variable; however, Laurent II's results show that decarboxylation selectivity only increases with sulfur content to about 2000 w-ppm, after which selectivity plateaus. Ex. 1011, Table 4 (reporting similar results for 49, 98, and 196 mmol/L sulfur). Beyond 2000 w-ppm, therefore, Laurent II teaches that sulfur concentration ceases to be result-effective. A person of ordinary skill in the art would have had no reason to optimize above about 2000 w-ppm sulfur, because Laurent II discloses no effect on decarboxylation selectivity beyond that point.[17]

REG raises another, related argument regarding Laurent II. Table 4 of the reference, in addition to reporting decarboxylation selectivity, also reports k_{DES}, the rate constant for the HDO reaction converting DES (di-ethyldecanedioate) at various levels of sulfur. Ex. 1011, 107, Table 4. According to Dr. Sughrue, these results indicate that the activity of the HDO catalyst continues to increase above 2000 w-ppm sulfur, and is still increasing at 8000 w-ppm. Ex. 1043 ¶ 125. Dr. Sughrue testifies that this increased activity has the benefit of requiring less catalyst to be used to deoxygenate the feedstock. *Id.* REG contends that this benefit provides another reason for the person of ordinary skill to use sulfur concentrations in the claimed 5000–8000 w-ppm range. Mot. Opp. 11.

We are not convinced by REG's rate constant argument. First, REG does not direct us to any evidence in the record, other than the testimony of Dr. Sughrue, that establishes that increasing the rate constant of the conversion reaction was recognized in the art to be beneficial. This is in stark contrast to decarboxylation selectivity, which is described by several

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[17] Furthermore, as discussed above with respect to Laurent I, we do not find such a significant increase in sulfur concentration—from 2000 to 5000–8000 w-ppm—to be "routine."

references as decreasing hydrogen consumption and, therefore, processing cost. We are, therefore, left with only Dr. Sughrue's statement that an "increase in rate constant is important because a higher activity allows for less catalyst to be used to deoxygenate the feedstock." Ex. 1043 ¶ 125. Dr. Sughrue cites no support for such an assertion, and we accord it little weight. *See* 37 C.F.R. § 42.65(a) ("Expert testimony that does not disclose the underlying facts or data on which the opinion is based is entitled to little or no weight.").

Second, we note that Table 4 of Laurent II reports, along with k_{DES}, the rate constants k_{4MA} and k_{GUA}, pertaining to the HDO conversion of 4-methylacetophenone and guaiacol, respectively. Ex. 1011, 107. While k_{DES} is shown to increase with sulfur concentration, k_{4MA} decreases and k_{GUA} is unaffected by sulfur concentration. *Id*. REG provides no evidence or argument establishing why a person of ordinary skill in the art would have considered only the k_{DES} rate constant in determining the benefit of increased sulfur concentration.

Finally, we note that although Laurent II is cited to establish a reason to combine references in both the Petition and Opposition to the Motion to Amend, Laurent II's rate constant results were never mentioned as part of the Petition or Dr. Sughrue's first Declaration. The Petition describes Laurent II as finding that increased sulfur concentration "led to increased decarboxylation." Pet. 32. Similarly, Dr. Sughrue testifies that Laurent shows that "decarboxylation of fatty acids and fatty acid esters in a hydrotreating process is promoted by the inclusion of sulfur, and that such decarboxylation adventitiously decreases hydrogen consumption." Ex. 1002 ¶ 58. Although Petitioners are not prohibited from raising new arguments to respond to a Motion to Amend, as noted above Laurent II was cited for a similar proposition in both sets of briefing: that the reference provided reason to add a particular concentration of sulfur to an HDO stream. *Compare* Ex. 1002 ¶ 132 (claim 22's range of 2000–5000 w-ppm sulfur) *with* Ex. 1043 ¶ 93 (claim 25's range of 5000–8000 w-ppm sulfur). The fact that neither REG nor Dr. Sughrue initially raised Laurent II's rate constant results smacks of hindsight reasoning.

For these reasons, we do not find that a person of ordinary skill in the art would have had reason to use 5000–8000 w-ppm sulfur in the process of Jakkula, based on either the decarboxylation selectivity or rate constant results reported in Laurent II.

2. Conclusion Regarding Patentability of Claim 25

Based on the record before us, we conclude that Neste has carried its burden of demonstrating that claim 25 is patentable over the prior art of record. We concluded above, in discussing the original claims, that a person of ordinary skill in the art would have had reason to combine Jakkula and Monnier I to add sulfur to the feedstock of an HDO process that is followed by an HI step, because the prior art suggests that concentrations of 2000 or 4431 w-ppm have beneficial effects on catalyst activation and decarboxylation selectivity. A person of ordinary skill would, therefore, weigh the possible deleterious effects of sulfur on the HI catalyst, against the possible benefits.

The question of whether a person of ordinary skill in the art would have had reason to add an even higher concentration of sulfur—in the range of 5000–8000 w-ppm—is an altogether different one. The record before us does not establish persuasively that there was any art-recognized benefit to using a concentration of sulfur over 4431 w-ppm. Absent any indication of a benefit to be obtained from adding even greater amounts of sulfur, the skilled artisan would have no reason to make the modifications to Jakkula necessary to result in the claimed invention. Such modifications would involve catalyst replacement costs, additional processing steps such as stripping, or catalyst substitutions[18] that—although not prohibitive if the prior art suggested a benefit might be obtained—would not be undertaken if the person of ordinary skill saw no benefit to making them.

For these reasons, we conclude that Neste has established sufficiently that there was no reason to modify the prior art to arrive at the process of claim 25.

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[18] For example, although REG correctly notes that Prada discloses an HI catalyst that can tolerate up to 10,000 w-ppm sulfur (Mot. Opp. 4; Ex, 1059, 7:36–38), there would be no reason to modify Jakkula to use the Prada catalyst unless the prior art suggested some gain would result from using such high sulfur levels. As discussed above, the art of record reflects that decarboxylation selectivity reaches a maximum at, at most, 4431 w-ppm. We also note that REG has not set forth a proposed ground of unpatentability based on the combination of Prada with Jakkula.

3. Dependent Claims

Proposed substitute claims 26–28 correspond to original claims 14, 16, and 17, but are rewritten to depend from proposed substitute claim 25. This is the proper technique for maintaining claim dependencies from an amended independent claim. *See Toyota Motor Corp. v. Am. Vehicular Scis. LLC*, Case IPR2013-00419, slip op. at 2 (PTAB Mar. 7, 2014) (Paper 32) (discussing prohibition on "amending in place").

Because we conclude above that claim 25 is patentable, we reach the same conclusion with respect to its dependent claims. Neste has established by a preponderance of the evidence that claims 26–28 are patentable over the prior art of record.

III. CONCLUSION

We conclude that REG has demonstrated, by a preponderance of the evidence, that claims 1–24 of the '492 patent are unpatentable under 35 U.S.C. § 103, as having been obvious over combinations of Jakkula, Monnier I, Gunstone, Toeneboehn, Oldřich, and Monnier II, as follows:

Claims 1–3, 5–21, 23 and 24: Jakkula, Monnier I, and Gunstone;
Claim 4: Jakkula, Monnier I, Gunstone, and Toeneboehn;
Claims 5, 6, 20, and 21: Jakkula, Monnier I, Gunstone, and Oldřich;
Claim 22: Jakkula, Monnier I, Gunstone, and Monnier II.

In addition, we conclude that Neste has demonstrated, by a preponderance of the evidence, that proposed substitute claims 25–28 are patentable over the prior art, and that it is entitled to entry of the proposed substitute claims. We, therefore, *grant* Neste's Motion to Amend Claims.

IV. ORDER

Accordingly, it is

ORDERED that claims 1–24 of U.S. Patent No. 8,278,492 B2 are *unpatentable*;

FURTHER ORDERED that Patent Owner's Motion to Amend is *granted* as to proposed substitute claims 25–28;

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 1–24 and incorporating claims 25–28 in U.S. Patent No. 8,278,492 B2; and

FURTHER ORDERED that, because this is a final 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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