**UNITED STATES PATENT AND TRADEMARK OFFICE**

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**BEFORE THE PATENT TRIAL AND APPEAL BOARD**

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TOPSOE, INC.,
*Petitioner*

v.

CASALE,
*Patent Owner*

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IPR2025-01454
U.S. Patent No. 11,286,168

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# REPLY DECLARATION OF DR. JAMES A. RITTER

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## I. Introduction

1. I previously submitted a declaration in this proceeding (EX1005), which sets out my qualifications (EX1005 ¶¶1-16 and Appendix A), the legal standards I applied (*id.* ¶¶17-31), and my opinions regarding U.S. Patent No. 11,286,168 (the "'168 Patent"). I incorporate that declaration here and apply the same legal standards.

2. I have been asked to respond to the Patent Owner Response (Paper 33, "POR"), the declaration of Dr. Colin Wolden (EX2007), and Patent Owner's characterizations of my April 30, 2026 deposition testimony (EX2008). In preparing this declaration I reviewed those materials, together with EX2009, EX2010, and EX2011, the Nielsen declaration (EX1045), the deposition transcript of Dr. Wolden (EX1066), and the materials cited in my first declaration.

3. The opinions below respond to arguments and evidence in the POR and the Wolden declaration, address characterizations of my deposition testimony, and explain and elaborate the analyses set out in the Petition and my first declaration. I do not offer testimony related to any new ground of unpatentability, rely on any new prior art reference, or rely on any portion of a reference not previously identified in my first declaration or the Petition.

4. My compensation is unchanged from EX1005 ¶13 and does not depend on the outcome of this proceeding or the substance of my opinions.

5. **Level of ordinary skill**. Dr. Wolden proposes a definition of the person of ordinary skill in the art ("POSA") that differs modestly from mine. EX2007 ¶¶18-20; POR 7. Patent Owner acknowledges the difference is immaterial (POR 7), and I agree: my opinions are the same under either definition, and I understand Dr. Wolden does not contend otherwise. I also note that under either definition, the POSA is a chemical engineer with experience in synthesis gas processes, a point relevant to Section VII below.

## II. Public Accessibility of 2007 IFA

6. In my opinion, the search Dr. Wolden ran does not address the relevant period. Dr. Wolden's searchability opinions (EX2007 ¶¶62-64) rest on searches he performed on the IFA's current website in 2025-26. As I understand it, the relevant question is whether an interested skilled artisan exercising reasonable diligence could have located 2007 IFA before the March 2017 critical date. Dr. Wolden does not analyze the IFA website's organization, indexing, or search function as it existed between 2007 and 2017. My first declaration addressed that period: the Wayback Machine capture of March 10, 2010 (EX1019) shows the IFA's Technical Committee Meeting page as it existed then, organized by conference, a conference expressly titled "Energy Efficiency and $CO_2$ Reduction, Prospects in Ammonia Production," with a download link for 2007 IFA. EX1005 ¶¶83-88.

7. Even on the current site, Dr. Wolden's own footnote acknowledges that the search he ran returned the conference proceedings volume that contains the complete 2007 IFA presentation (EX1017). EX2007 ¶64 n.18. And the document's own title, "Future Energy Efficiency and $CO_2$ Reduction Potential," discloses its subject matter to anyone researching $CO_2$ reduction in ammonia production, the very topic Patent Owner says the industry had been focused on "for decades." POR 64. In my experience, and as reflected in my first declaration, a POSA in ammonia process engineering knew the IFA, the industry's international trade association, and its website as a repository of technical-meeting materials. EX1005 ¶¶84-87.

8. **The "/2023/" file path reflects a website migration, not first publication.** Patent Owner infers from the "/wp-content/uploads/2023/01/" file path that 2007 IFA may not have been posted until 2023. POR at 18-19. In my opinion, that inference is not consistent with the record or with the ordinary operation of websites. The "/wp-content/uploads/" structure is the file architecture of the WordPress platform; when an organization migrates its site, its existing document library is re-uploaded into that structure and the folder dates reflect the migration, not original publication. Consistent with that, the pre-2023 IFA documents I examined share the same "/2023/" path regardless of their original dates. Moreover, the March 10, 2010 Wayback capture (EX1019) shows the prior site architecture hosting a download link for 2007 IFA seven years before the

critical date, which the document could not have done had it first been posted in 2023. I am aware of no evidence that the archived link was inoperative.

9. **The claimed Lako "discrepancy" is a unit conversion.** Patent Owner asserts that one of two values in the Lako study differs from 2007 IFA (6.89 versus 6.8 Gcal/t) and infers Lako may not have had the presentation. POR at 17 & n.13. In my opinion, that inference is not supported by the arithmetic. Lako's Table 3.5 reports energy intensities in GJ per tonne alongside Gcal figures. EX1020 at 22. One Gcal equals 4.1868 GJ; 28.8 GJ/t ÷ 4.1868 = 6.88-6.89 Gcal/t. The "6.89" endpoint is therefore Lako's own conversion of its GJ figure, not a misquotation of the slides. Meanwhile, Lako reproduces 2007 IFA's revamp figure exactly, quoting "at best 7.1 Gcal/t $NH_3$ … according to (Nielsen, 2007a)," which matches slide 2's "best current plant is today around 7.1 Gcal/MT $NH_3$ after revamp." Compare EX1020 at 22 with EX1006 at 2. Lako's bibliography gives the complete citation for 2007 IFA (author, title, conference, dates, city) and cites additional presentations from the same 2007 meeting. EX1020 at 22, 25, 44; EX1005 ¶¶89-91. In my opinion, the Lako study demonstrates that an interested, skilled researcher located and used 2007 IFA, and the conference corpus generally, well before the critical date.

10. Finally, I note that my opinions in this section, and the corresponding opinions in my first declaration (EX1005 ¶¶83-91), rest on my own review of the

IFA website, the conference proceedings volume (EX1017), the archived March 10, 2010 website capture (EX1019), and the Lako study (EX1020). The Nielsen declaration (EX1045) corroborates those opinions, but they do not depend on it: the archived capture and the Lako study independently show that 2007 IFA was posted on, and located through, the industry's own repository years before the critical date.

## III. "Furnace"

11. **How a POSA reads the passage at 2:47-55.** Dr. Wolden treats the first sentence of column 2's furnace passage (2:47-55) as a closed list of four apparatus. EX2007 ¶¶25-26. A POSA would not stop at the first sentence. The passage continues: "These apparatus, which operate by means of combustion, are identified by the term 'fired heater.'" EX1001, 2:50-52. "Fired heater" is a recognized term of art in process engineering: it denotes the general class of process equipment in which fuel is combusted to supply heat, the class to which steam reformers, charge preheaters, fired steam generators, and fired superheaters all belong. Dr. Wolden agrees that the term "fired heat" is used in the '168 patent to "match" the term "furnace." EX1066, 177:22-178:19. The passage thus tells the POSA what kind of apparatus the four names exemplify: combustion-fired process heaters. The immediately following sentences confirm the open, functional usage: "said furnace" may form part of the natural-gas conversion section, and

"[i]n combined ammonia/urea plants said furnace may form part of the urea section." EX1001, 2:52-55. Patent Owner's own later-filed application uses the same industry vocabulary, equating "fired heater/process furnaces." EX2011 [0094].

12. **The specification does not support Dr. Wolden's heat-versus-electricity dichotomy.** Dr. Wolden opines that a furnace "transfer[s] thermal energy" whereas a turbine "generate[s] electricity." EX2007 ¶26. The '168 Patent itself teaches otherwise: it describes producing "the electricity necessary for the synthesis of ammonia … using as fuel $CO_2$-depleted synthesis gas," including by "expansion in a turbo generator of a flow of steam produced in a steam generator or steam superheater, fed by the $CO_2$-depleted synthesis gas as fuel," and by "combustion in a gas turbine or in a gas engine, fed by the $CO_2$-depleted synthesis gas as fuel." EX1001, 7:44-53. In other words, the patent uses a "steam generator," one of the four apparatus on Dr. Wolden's list, precisely to make electricity, fired by the same fuel fraction recited in claim 1. A POSA reading the specification as a whole would understand that the patent draws no line between "heat" equipment and "power" equipment; it describes one integrated class of combustion equipment fired by the fuel fraction. This analysis and conclusion is reflected in my first declaration. EX1005 ¶60.

13. **"Steam generator" as a class does not inherently require combustion.** If, as Patent Owner's proposed construction has it, "furnace" simply means an apparatus chosen from the four-item list without more, I note as a technical matter that the class "steam generator" includes apparatus that generate steam without combustion: electric boilers, nuclear steam generators, and unfired heat-recovery steam generators, among others. The only combustion limitation in the passage comes from the second sentence, the sentence Patent Owner's proposed construction omits but its merits argument invokes. POR 8, 28. Dr. Wolden agrees, explaining his opinion that a HRSG is not a "furnace" even though it is a "steam generator" because he has incorporated the "functional requirement of combustion". EX1066, 236:18-237:19.

14. **My deposition testimony.** The POR quotes fragments of my deposition concerning a "gas grill" and similar hypotheticals. POR 11-12. Those questions asked me about the outer boundaries of the term "fired heater" in the abstract, and my answers were qualified in the moment. For example, I explained that whether such a device is a relevant "fired heater" "[d]epends on the application," and that a gas grill would not "function very well in a chemical process plant." EX2008, 67:17-68:11. My operative testimony was, and remains, that a POSA reads "furnace" in the '168 Patent as "a fired heater where combustion takes place," EX2008, 61:7-10; that a gas turbine, by definition,

operates by combustion and includes a furnace, its combustor, EX1005 ¶¶56, 60; EX2008, 80:11-81:13; and that a gas turbine operated in cogeneration "generate[s] electricity … with the off-gas being used to generate steam—hence, a steam generator, which is one of the examples in Column 2." EX2008, 82:6-13. Nothing in my deposition altered the opinions in my first declaration.

15. **Dr. Wolden's opinion regarding the ordinary meaning of "furnace."** In his deposition Dr. Wolden agreed with my definition for the ordinary meaning of the term "furnace," stating that "a furnace consists of basically two operations: a combustion unit, which creates heat; and a heat exchanger, which transfers that heat from the combustion gases to another fluid." EX1066, 181:20-182:2. A POSA would therefore consider a gas turbine/HRSG unit to be a "furnace" either: (1) based on PO's lexicography theory (a "steam generator" using the hot gases from fuel combustion in the gas turbine); or (2) based on its ordinary meaning (combustion of fuel in the gas turbine to form hot flue gas for the purpose of heat transfer to generate steam).

## IV. 2007 IFA—Ground 1

16. **Slide 18 is one integrated flowsheet.** The "Integrated reforming and power cycle" flowsheet (EX1006 at 9) depicts, in a single diagram: desulfurization; a pre-reformer feeding an oxygen-fed autothermal reformer (with no primary reformer between them); shift conversion; $CO_2$ removal; and,

immediately downstream of $CO_2$ removal, a split of the $CO_2$-depleted synthesis gas into a stream expressly labeled "H2 Fuel" and a stream routed through the methanator to become "Ammonia Syngas." EX1005 ¶92. In my opinion, contrary to Dr. Wolden's suggestion that the claim elements must be assembled from "unlinked" slides (EX2007 ¶¶69-77; POR 27-28), every element of claim 1 appears in this one flowsheet.

17. **The $H_2$ fuel is fed to a gas turbine/HRSG unit for combustion and steam/power co-generation**. The $H_2$ Fuel line feeds the gas-turbine/HRSG power train at the lower left of slide 18. EX1006, p.9, lower slide. I understand that Dr. Wolden states that this is a not a "furnace" within the meaning of the '168 Patent because a HRSG is just a "heat exchanger" whereas a furnace is "combustion plus heat exchanger." EX1066, 209:19-210:12. This ignores that a gas turbine/HRSG is designed and built by a POSA as one integral unit for the cogeneration of steam and power. The gas turbine does not typically have a separate flue gas stack, its combustion products are emitted to the atmosphere after its heat has been recovered in the HRSG as superheated steam. I agree with Dr. Wolden that the combustion reaction occurring in a gas turbine and the combustion reaction occurring in a traditional steam generating furnace are the "same" (EX1066, 227:19-22), although I note that a POSA would understand that the exhaust from a gas turbine will contain much more unreacted oxygen because gas turbines operate

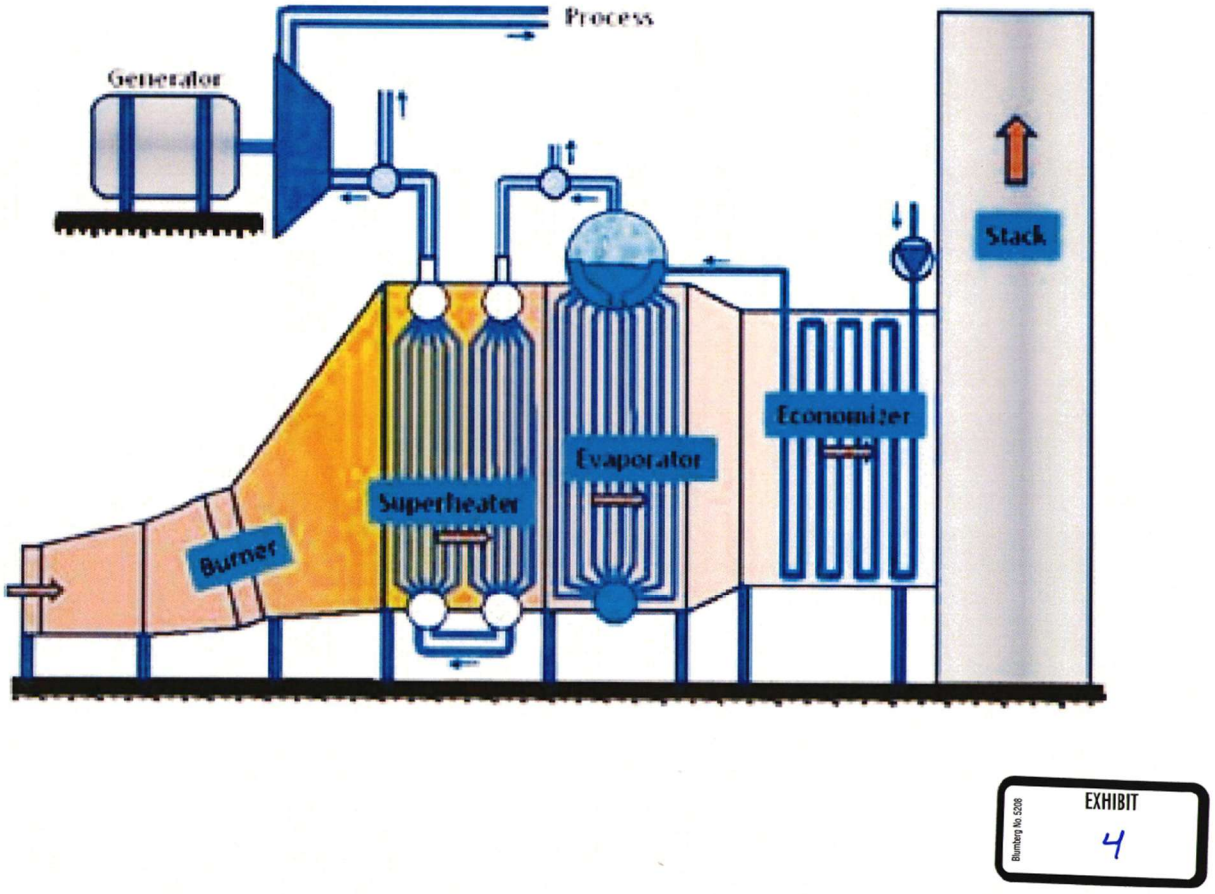
at 2-4 times the stoichiometric amount of air needed for combustion (called "lean combustion") in order to control temperature (to minimize NOx formation and to protect turbine blades).

18. POSA would understand that the gas turbine/HRSG depicted in slide 18 operates by: (1) combusting its fuel in a combustion chamber, producing a high-temperature, high-pressure gas; (2) generating electricity as the combustion gases spin the turbine shaft; (3) flowing the gas exhaust (typically 450-650°C) directly into a Heat Recovery Steam Generator (HRSG) where superheated steam is produced.

19. A POSA would understand the structure and operation of a typical HRSG, which consists of (from coolest sections to hottest): a stack for emitting flue gas to the atmosphere, an economizer for preheating boiler feedwater, a saturated steam evaporator for producing saturated steam, and a steam superheater for producing superheated steam. A POSA would know that this gas turbine/HRSG arrangement has existed commercially in chemical plants for the cogeneration of power and steam since the 1940's, and is functionally identical in structure and operation to a typical steam generating furnace.

20. This is especially true when the HRSG features supplementary duct burners: the HRSG would therefore have its own "radiant section" that would

identically mimic a typical steam generating furnace. An example of a supplementary duct-fired HRSG is depicted in Exhibit 4 of the Wolden deposition:




EX1067. This Exhibit 4 accurately depicts a HRSG with an additional burner that would combust fuel with the excess oxygen contained in the gas turbine exhaust entering the HRSG from the left. Although Dr. Wolden refused to acknowledge that Exhibit 4 is a HRSG, it is noteworthy that Dr. Wolden admits that Exhibit 4 depicts a steam generating furnace EX1066, 204:19-206:8. As Dr. Wolden agreed, the produced superheated steam from a HRSG or from a steam boiler can be used

for heating within the plant or can be used to generate additional power using a steam turbine—the use of steam to subsequently produce power does not disqualify a unit from being a "steam generator." EX1066, 217:21-218:7.

21. Furthermore, in the context of emissions reporting, a POSA would understand that a gas turbine/HRSG is reported as a single emissions unit, as the flue gas stack is downstream of the HRSG. Even when the HRSG includes additional duct burners, a POSA would understand that the gas turbine/HRSG is still reported as a single emissions unit (i.e., combined gas turbine and duct burner emissions).

22. As shown in slide 18 of 2007 IFA, the $H_2$ Fuel is therefore fed to, and burned in, a furnace within the plain meaning of that term as I have explained it. EX1005 ¶¶56, 60, 92-93; EX2008, 115:1-17. Slide 18 also demonstrates that the $H_2$ Fuel is burned in a "steam generator" within the lexicography definition advanced by Dr. Wolden.

23. **Slides 15-17 confirm the Gas Turbine/HRSG configuration.** A POSA does not read a slide in isolation; the presentation develops one integration concept across consecutive slides. Slide 15 lists the $CO_2$-reduction levers, including "[i]mprove efficiency of steam and power generation unit in the complex." EX1006 at 8. Slide 16, titled "Integration of gas turbine driver in the ammonia process," details that steam-and-power unit: a "Package HP Steam

Boiler" receiving Fuel and boiler feedwater ("BFW") and exhausting to a Stack, producing superheated high-pressure steam for a steam turbine. *Id*. A stack emits the combustion products from the fired boiler to the atmosphere. As I explained in my first declaration, in this configuration "[t]he fuel is combusted to drive a turbine, heat is recovered for steam generation, and fuel also is combusted to generate steam from boiler feedwater." EX1005 ¶93. At deposition I explained the same configuration: additional fuel is mixed with the oxygen-bearing turbine exhaust and combusted in the high-pressure steam boiler: "you can tell it's combusted because that line goes to the stack…. So emphatically, those are furnaces." EX2008, 115:1-17. Slide 17 then enumerates the "Steam and Power Production" unit's configurations for the integrated complex, including "(c) Gas Turbine + MP Steam Boiler" and "(d) Gas Turbine + HP Steam Boiler." EX1006 at 9. A POSA accordingly reads the GT/HRSG train of slide 18 as that same combustion-fired steam-raising unit. EX1005 ¶¶92-93.

24. **Dr. Wolden's "Fuel means natural gas" argument is not consistent with the presentation.** Dr. Wolden reasons from slides 13 and 16 that "Fuel" denotes hydrocarbon fuel. EX2007 ¶¶78-84; POR 24-26. I make two observations. First, for claim 1 the fuel's identity comes from slide 18 itself, which labels the stream "H2 Fuel" and shows it split from the CO2-depleted syngas, so no inference is required. Second, the presentation's labeling is deliberate: where

the slides intend natural gas, they say so ("Natural Gas," "Ref. Fuel," "Aux. Fuel" on slides 17-18).

25. Slide 16's generic "Fuel" label describes the steam-and-power island whose entire point, in the presentation's progression, is to be fired with the decarbonized fuel to reduce CO2 emissions. EX1006 at 8-10. This conclusion is also informed by the title of slide 16: "Integration of gas turbine driver in the ammonia process." If "Fuel" is read as natural gas only, as Dr. Wolden argues, then slide 16 represents no integration with the ammonia process at all—the only integration with the ammonia process is the inclusion of $H_2$ Fuel as part of "Fuel" as specifically taught in Slide 18.

26. **Claim 10**. The fuel fraction feeds a steam production furnace: the fired HP steam boiler of slide 16 and the gas-turbine-HRSG of slide 18, as set out in my first declaration. EX1005 ¶205. Dr. Wolden's observation that 2007 IFA does not depict a furnace preheating the ATR charge (EX2007 ¶¶85-88) does not address this disclosure, which I understand independently satisfies the claim's alternatives.

27. **Claims 3-4 (fuel-fraction percentage)**. Patent Owner's cited passage (EX1001, 2:64-3:4) confirms my opinion rather than rebutting it: the passage explains that directing more syngas to fuel reduces $CO_2$ emissions and requires producing more make-up syngas. That is the definition of a result-effective

allocation: the designer selects the fraction based on the $CO_2$-reduction target and the plant's fuel demand, balancing exactly the considerations the specification recites. The specification identifies multiple nested ranges without attributing any distinct or unexpected result to the claimed boundaries. EX1005 ¶¶170-77. Patent Owner's "counterintuitive economics" theme (POR 33-35) describes a commercial preference, not a technical obstacle: 2007 IFA's entire premise is spending hydrogen as fuel to reduce $CO_2$ (EX1006 at 8-10), and Rytter expressly directs at least 5% of the stream to synthesis with the remainder to fuel and other uses (EX1008, 4:10-14), which is express allocation guidance within the claimed ranges. EX1005 ¶¶240-45. The allocation decision is the same whether the syngas serves an ammonia or a methanol back end; both references contemplate ammonia. EX1008, 3:12-16, 4:41-57, 7:26; EX1005 ¶95.

28. **Claim 7 (≤1000 ppm $CO_2$)**. Patent Owner argues the limit "is required to meet the plant emissions targets." POR 36. I agree, which is why the residual $CO_2$ level is a result-effective variable: the CO2 left in the fuel gas is the $CO_2$ emitted at the stack, so a POSA pursuing 2007 IFA's stated objective, including "reduce the CO2 emission to zero" (EX1006 at 10), optimizes removal depth directly toward the target. EX1005 ¶¶190-96. Independently, slide 18's flowsheet includes a methanator, whose function a POSA knows: converting residual CO and $CO_2$, which poison ammonia-synthesis catalyst, to methane. Its

presence tells the POSA the design already drives residual $CO_2$ to very low levels. EX1005 ¶¶51-55.

29. **Claims 8-9 (oxygen concentration)**. Slide 18 expressly feeds the ATR with "Oxygen." EX1006 at 9; EX1005 ¶46. The '168 Patent recites several advantages for oxygen-enriched operation: higher calorific value of the comburent, reduced flue-gas flow, and smaller equipment. EX1001, 3:36-43. These were the art-recognized, expected benefits of enrichment long before 2017, as reflected in the record. EX1031 ¶¶16-17; EX1041 at 1; EX1005 ¶¶197-203. Reciting the known benefits of a known technique is not evidence of criticality.

30. **Claim 11 (purge-gas recovery and recycle)**. 2007 IFA expressly lists a "Cryogenic purge gas recovery unit" returning "recovered hydrogen at high pressure" among the plant's energy-efficiency features. EX1006 at 2-3. To a POSA, purge-gas "recovery" means separating the purge into a hydrogen-rich stream and a methane-rich tail gas; returning the tail gas to the front end as fuel or feed was conventional decades before the critical date, as the '168 Patent itself acknowledges. EX1001, 1:63-66; EX1016 at 3-4; EX1005 ¶¶210-14. Patent Owner's annotation showing purge gas "leaving the system" (POR 37) does not address the recovery-unit disclosure. As for Ji, in my opinion Patent Owner's "coal-to-methanol" characterization (POR 57-59) is incomplete: Ji's separation-and-recycle process is expressly directed to chemical production including

ammonia (EX1012, Abstract, 1:17-24), and it is cited for the narrow, well-known step of splitting purge gas into $H_2$-rich and $CH_4$-rich fractions with recycle, a step whose implementation does not depend on the upstream gasifier. EX1005 ¶¶210-19, 252-55.

31. **Claim 17 (fuel allocation; trim fuel)**. Dr. Wolden observes that slide 18 shows natural gas and nitrogen lines joining the $H_2$ fuel ahead of the gas turbine and calls my reading "factually wrong." EX2007 ¶91. Neither line is inconsistent with my opinion. Nitrogen addition to hydrogen fuel is a known combustion-moderation technique (flame temperature and NOx control), and it accompanies hydrogen firing rather than replacing it. A natural-gas connection provides startup, backup, or trim duty; claim 17 itself permits natural-gas trim up to 15%. The allocation between generated H2 fuel and trim is an operational design choice, as the '168 Patent's own trim-fuel discussion reflects (EX1001, 3:44-52), and Licht discloses the full-substitution endpoint: hydrogen and by-product gas firing the reformer with "[n]o natural gas trim fuel." EX1009, 5:37-42, 10:4-9; EX1005 ¶¶220-24, 256-59.

## V. Rytter—Ground 2

32. **Limitation 1(a).** Rytter states that the autothermal reformer is "fed … a prereformed natural gas." EX1008, 4:30-33. A POSA reads that disclosure as written: the gas delivered to the ATR is characterized as prereformed, meaning

pre-reformer to ATR. Where Rytter intends a steam (primary) reformer in the train, it says so expressly: its "particularly preferred" plant "consists of an autothermic reformer combined with a steam reformer and a prereformer." EX1008, 4:17-20. In my opinion, Dr. Wolden's contrary reading, that "prereformed natural gas" could also have passed through an unmentioned primary reformer (EX2007 ¶¶99-102), would require an apparatus that appears nowhere in the cited disclosure; he identifies no figure, claim, or passage placing a primary reformer between the pre-reformer and the ATR. And the pre-reformer-plus-ATR configuration (no primary reformer) was itself a familiar arrangement before 2017. Slide 18 of 2007 IFA depicts exactly that. EX1005 ¶¶45-49, 95.

33. **Limitation 1(c)**. Rytter described feeding the $H_2$ stream as fuel to two different fired apparatus. Part of the $H_2$-containing stream "is fed to the reforming plant as a fuel" (EX1008, cl. 11; 4:55-57), and reformers are fired by burners that combust the fuel. And hydrogen power station 7 is "supplied with air for the combustion of the hydrogen gas to steam producing electrical power." EX1008, 6:8-13. Combusting fuel to raise steam is a "steam generator" operating by means of combustion; that the steam then generates electricity is precisely the use the '168 Patent itself describes for its fuel fraction. EX1001, 7:44-53; EX1005 ¶¶95-96, 142-43.

34. **Column 9 does not teach away.** The passage Patent Owner quotes (EX1008, 9:6-26) identifies the design parameters that change when a combustor designed for methane is used with hydrogen-rich gas: combustion energy, flame displacement velocity, explosion limits, and spontaneous-ignition temperature. It is a design discussion within a reference that affirmatively teaches combusting the hydrogen-rich stream in the reforming plant's burners, in the power station, and as turbine fuel. Identifying the parameters to account for is how an engineer follows the reference's path, not a statement that the path should be abandoned; adapting burners and combustors to hydrogen-rich fuels, including by dilution with nitrogen or steam, was within the ordinary skill of a POSA before 2017. Nothing in column 9 states or suggests that hydrogen firing is unworkable or unproductive.

## VI. Fjellhaug—Grounds 3/3A/3B

35. **The oxygen-moles point**. Dr. Wolden calculates that blending turbine exhaust with air yields a stream below 21% $O_2$ by volume and concludes the ATR is not supplied "with oxygen-enriched air or with oxygen." EX2007 ¶¶114-15. As discussed earlier, I disagree with Dr. Wolden that a commercial gas turbine does not operate with excess air—in fact, a POSA would understand that commercial gas turbines often operate with 2-4x the stoichiometric amount of required air for combustion, in order to cool the combustion gases to protect turbine blades and to reduce NOx formation. This results in a gas turbine exhaust having up to 15% or

more oxygen (dry basis), depending in part on the gas turbine design and load. Although this results in a lower $O_2$ % compared to air (at ~21%), this additional exhaust undoubtedly serves to add $O_2$ moles to the ATR, which a POSA would understand is the primary purpose for recycling this particular stream to the ATR. EX1010, col. 3:28-29 (". . .recycled to the ATR as an oxygen source . . ").

36. Dr. Wolden's percentage calculation does not address the point I made at deposition: Fjellhaug recycles exhaust to the ATR "as an oxygen source" (EX1010, 3:28-29); the purpose "is to get more moles [of oxygen] fed to the reactor." EX2008, 150:12-19; EX1005 ¶¶46, 127.

37. **The air-versus-oxygen tradeoff was documented in the art**. In any event, as set out in the Petition, Rytter supplies "substantially pure $O_2$" to the conversion section. EX1008, 4:26-29. Fjellhaug itself frames its air-driven choice as a departure from the known oxygen-driven ATR of the prior art it discusses (EX1010, 1:43-52, 2:13-28); that is, oxygen-fed ATRs were a known, workable alternative before Fjellhaug. The tradeoff was familiar to every practicing engineer: an air separation unit costs capital, but oxygen operation avoids nitrogen dilution, reduces equipment size, and improves syngas quality, the very benefits the '168 Patent recites at 3:36-43. Selecting between two known options with understood, documented costs and benefits is routine engineering judgment; the benefits of the oxygen option are documented in the record art, not asserted after

the fact. EX1005 ¶¶127, 278-84. Fjellhaug's preference for air, in service of producing a lean gas for its particular combined-cycle turbine (EX1010, 2:16-28), neither criticizes nor discredits the oxygen alternative.

## VII. The Combinations

38. **The common front end**. Patent Owner repeatedly argues that a POSA designing an ammonia plant would not consult references directed to methanol, hydrogen, power generation, or Fischer-Tropsch synthesis. That is not how the field works, and it is not how the references describe themselves. Steam reforming, pre-reforming, autothermal reforming, shift conversion, $CO_2$ removal, and final purification are the same unit operations across those processes; the "front end" that produces and conditions synthesis gas is common, and the syngas literature is a single body of knowledge that front-end designers consult regardless of the downstream product. EX1005 ¶¶40-49. Rytter itself benchmarks its process against "standard technology today in the production of hydrogen for the synthesis of ammonia" and directs its $H_2$ stream to ammonia among other uses. EX1008, 3:12-16, 4:41-57, 7:26. Price is cited for front-end fundamentals that do not depend on the ultimate product: conventional purification, residual $CO_2$ levels, and steam-to-carbon ratio. EX1011 ¶¶5, 39-45, 53-59; EX1005 ¶¶159-68.

39. **My deposition testimony about "interest in methanol."** The POR quotes my statement that "[m]y group didn't have interest in methanol." POR 58,

62; EX2008, 45:14-46:24. That answer described the research focus of my academic laboratory at the University of South Carolina, meaning what my graduate students and I chose to study. It did not describe the scope of the art a POSA is charged with knowing, and it did not describe my own familiarity with methanol front-end technology. As I also testified, these references "all make a mixture of CO, $CO_2$, and hydrogen for a variety of uses. Ammonia happens to be one of them. Methanol happens to be one of them." EX2008, 176:17-24.

40. **"Cascade of effects."** Patent Owner converts my deposition acknowledgment that process changes have downstream consequences (EX2008, 160:8-161:12) into a rule that coupled chemical processes resist modification. POR 53-63. The acknowledgment is unremarkable: every design change in a chemical plant propagates through the heat and material balances, and accounting for that propagation is the ordinary, daily work of process engineers using conventional tools, such as resizing exchangers, rebalancing steam systems, and adjusting compression. Neither the POR nor Dr. Wolden identifies any specific consequence of the proposed combinations that a POSA could not have managed with routine methods, and the transplanted features at issue are narrow, conventional parameters: a percentage allocation, an oxygen concentration, a membrane purge-gas split, and a trim-fuel fraction. EX1005 ¶¶169-77, 197-203, 210-24, 240-90.

## VIII. Secondary Considerations

41. The POR quotes my deposition statement that I did not recognize the phrase "secondary considerations." The label is a legal one; the substance is technical, and my first declaration addressed it: I am aware of no commercial success, industry praise, licensing, or copying attributable to the challenged claims. EX1005 ¶337. That remains true. I would add that Patent Owner's "long-felt need" assertion is inconsistent with the record: the industry was actively pursuing the very approach the claims recite (substituting decarbonized hydrogen fuel and capturing $CO_2$) no later than 2007, as 2007 IFA itself demonstrates. EX1006 at 8-10.

## IX. Conclusion

42. Nothing in the POR, the Wolden declaration, or my deposition alters the opinions in my first declaration. The Challenged Claims are unpatentable for the reasons stated in the Petition and EX1005, as explained above.

## X. Declaration

43. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further, that those statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

8/3/26
Date

James A. Ritter, Ph.D.