

**UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF TEXAS
GALVESTON DIVISION**

TOPSOE, INC.,	§	
	§	
Plaintiff,	§	
	§	
v.	§	
	§	
CASALE S.A.,	§	
	§	
Defendant.	§	
CASALE S.A.,	§	Civil Action No. 3:24-cv-00033
	§	
Counterclaim Plaintiff,	§	Jury Trial Demanded
	§	
v.	§	
	§	
TOPSOE, INC. AND TOPSOE A/S,	§	
	§	
Counterclaim Defendants.	§	

TOPSOE’S INVALIDITY CONTENTIONS

Pursuant to Local Patent Rules 3-3 and 3-4 and the Court’s Docket Control Order (Dkt. 190), Plaintiff Topsoe, Inc. and Counterclaim Defendant Topsoe A/S (together “Topsoe”) provide their Invalidity Contentions and Subject Matter Eligibility Contentions (together “Invalidity Contentions”) for U.S. Patent No. 11,286,168 (the “’168 Patent” or the “Asserted Patent”). Specifically, Topsoe provides its Invalidity Contentions for Claims 1, 5, 8, 9, 10, 18, and 19 of the ’168 Patent (the “Asserted Claims”). Topsoe bases these Invalidity Contentions upon the information in its possession as of the date of service of these contentions.

For each Asserted Claim, Topsoe: (a) identifies each item of exemplary prior art that anticipates each Asserted Claim or renders it obvious; (b) specifies whether each item of exemplary prior art anticipates each Asserted Claim or renders it obvious; (c) submits charts identifying where specifically in each item of exemplary prior art each element of each Asserted Claim is found, including for each element governed by pre-AIA 35 U.S.C. § 112(6) or 35 U.S.C. § 112(f), the identity of the structure(s), act(s), or material(s) in each item of prior art that performs the claimed function; and (d) identifies any grounds of invalidity of any of the Asserted Claims based on indefiniteness, enablement, and written description under 35 U.S.C. § 112; and (e) identifies the grounds for invalidating Asserted Claims under 35 U.S.C. § 101.

By submitting these Invalidity Contentions, Topsoe does not waive any of its claims or defenses in this case, including those relating to written description, enablement, indefiniteness, best mode, anticipation, and obviousness. References not included in these Invalidity Contentions, whether known or not now known, may become relevant based on the claim constructions adopted by the Court, based on any amendment or supplement Defendant Casale, S.A. (“Casale”) makes to its Infringement Contentions, and/or based on discovery in this case.

Discovery in this action is in its early stages, the Court has yet to issue a claim construction order for disputed terms in this case, and the invalidity of the Asserted Claims will likely be the subject of expert discovery. Topsoe has included prior art (and arguments related to the same) that anticipates or renders obvious claims based on Casale’s apparent

claim constructions of certain terms to the extent they can be determined from Casale's Infringement Contentions. Casale's Infringement Contentions are deficient at least because they (1) fail to identify the specific service, system, product, or component that has actually been used to meet all limitations or portions of limitations; (2) fail to map the specific allegedly infringing service, system, product, or component thereof to certain claim limitations; and (3) provide confusing, unclear, and ambiguous contentions, often unsupported by the cited documents. These failures, and other failures, not only demonstrate Casale's failure to meet its burden of proof as to infringement but also have limited Topsoe's ability to understand Casale's position as to the scope of the claims directly relevant to these Invalidity Contentions. Topsoe expressly reserves the right to further amend these Invalidity Contentions as it learns more about Casale's Infringement Contentions, including in the event Casale supplements or amends its Infringement Contentions. Topsoe's service of these Invalidity Contentions does not represent a waiver of its position or rights to further pursue any relief to which it is entitled as a result of the deficiencies in Casale's Infringement Contentions.

Topsoe requested an inter partes review ("IPR") of the '168 patent. The Patent Office instituted an IPR of the '168 patent on February 10, 2026. PTAB-IPR2025-01454-15. As part of the IPR process, Topsoe stipulated that "if this IPR is instituted, Topsoe will not pursue in any district court litigation or ITC proceeding any invalidity ground that was raised or reasonably could have been raised in this IPR." PTAB-IPR2025-01454-9. This is commonly referred to as a *Sotera* stipulation. Thus, Topsoe does not rely on any invalidity

grounds in these invalidity contentions that could have been raised in the IPR. However, if the IPR is de-instituted, Topsoe hereby incorporates by reference the invalidity combinations set forth in its two IPR petitions, PTAB-IPR2025-01454-3; PTAB-IPR2025-01455-3, alone or in combination with the prior art identified herein, as if set forth herein.

Topsoe also reserves the right to amend, modify, and/or supplement these Invalidity Contentions based upon information obtained during discovery, including but not limited to the identification of additional prior art, as well as in response to any construction ruling issued by the Court or any position taken by Casale or its expert(s). Topsoe further intends to rely on inventor admissions concerning the scope of the Asserted Claims or of the prior art relevant to the Asserted Claims found in, inter alia: the patent prosecution histories for the Asserted Patents and related patents and/or patent applications; any deposition testimony of the named inventors of the Asserted Patents; and the documents that Casale produces and/or any evidence it submits in conjunction with this litigation or any related actions. Topsoe further reserves the right to rely upon any prior art, combinations of prior art, motivations to combine, and claim charts, as well as any grounds of invalidity based on 35 U.S.C. §§ 101 or 112, that are now or later identified by Topsoe. Topsoe's Invalidity Contentions are made in a variety of alternatives and do not represent Topsoe's agreement with Casale's apparent applications or views as to the meaning, infringement, definiteness, written description support for, or enablement of any Asserted Claims. A more detailed basis for Topsoe's contention that the Asserted Claims are invalid will be set forth in

Topsoe's expert report(s) on invalidity, to be served in accordance with the Court's Docket Control Order.

A. Identification of Prior Art that Anticipates Each Asserted Claim or Renders it Obvious

Topsoe identifies the following items of prior art that anticipate each Asserted Claim or render each Asserted Claim obvious. The identification of any patents and/or patent publications as prior art shall be deemed to refer to the application that was submitted for the same and to include identification of any prior-issued patents or prior publications in the family, foreign counterpart patents and applications, as well as any international applications. Concurrently with the service of these Invalidity Contentions, Topsoe is producing the prior art documents identified herein that have not previously been produced to Casale. Topsoe is identifying specific ammonia synthesis facilities based on Topsoe designs, but multiple other similar facilities include virtually identical designs, including the split-for-fuel feature, that are prior art to the Casale '168 Patent because the design was licensed by Topsoe and the plant was in operation demonstrating the design was prior art under 35 U.S.C. § 102 as "on sale", and/or known or used by others before the earliest priority date for the '168 Patent.

Topsoe also incorporates by reference all prior art known to Casale and all prior art and invalidity contentions served by any party on the predecessors-in-interest to the Asserted Patents including but not limited to the following produced by Casale in this action.

Produced Primary Reference Prior Art Documents Representing Systems:

- IFFCO Aonla-1 Ammonia plant, India. TOPSOE_0018096 (lean gas, normal case).
- QAFCO ammonia plant, Qatar.

TOPSOE_0029860	TOPSOE_0029867
TOPSOE_0029861	TOPSOE_0029868
TOPSOE_0029862	TOPSOE_0029869
TOPSOE_0029863	TOPSOE_0029870
TOPSOE_0029864	TOPSOE_0029874
TOPSOE_0029865	TOPSOE_0029879
TOPSOE_0029866	TOPSOE_0029943

- Tata Babrala ammonia plant, India.

TOPSOE_0029982	TOPSOE_0030000
TOPSOE_0029994	TOPSOE_0030001
TOPSOE_0029995	TOPSOE_0030002
TOPSOE_0029996	TOPSOE_0030003
TOPSOE_0029997	TOPSOE_0030004
TOPSOE_0029998	TOPSOE_0030005
TOPSOE_0029999	TOPSOE_0030024

Produced Secondary Reference Prior Art Patent Documents:

- US Patent No. 10,941,038 to Jensen et al. (“Jensen”). TOPSOE_0029838.

- US Patent No. 9,683,176 to Christensen. (“Christensen”). TOPSOE_0029832.
- US Patent App. Pub. No. US2009/0298957 to Gauthier, et al. (“Gauthier”). TOPSOE_0029846.
- US Patent App. Pub. No. US2002/0143219 to Price, et al. (“Price”). TOPSOE_0029817.
- U.S. Pat. No. 9,353,022 to Lindell, et al. (“Lindell”). TOPSOE_0029825.

Produced Secondary Reference Prior Art Publication Documents:

- 2007 IFA International Conference Presentation by Svend Erik Nielsen entitled “Future Energy Efficiency and CO₂ Reduction Potential” (“Nielsen 2007”). TOPSOE_0030113.

Table 1: Prior Art System Primary References for the Asserted Patent

No.	Title	Date of Public Use/Sale	Owner
1.	IFFCO Aonla-1 Ammonia plant, India	Approx. 1985	IFFCO
2.	QAFCO ammonia plant, Qatar	Operating approx. 2014	QAFCO
3.	Tata Babrala ammonia plant, India	Operating approx. 1994; expansion project approx. 2010	Yara International (current); Tata Chemicals Ltd. (previous)

Table 2: Patent Secondary References for the Asserted Patent

No.	Number and Name	Country of Origin	Issue Date/Date of Publication	Filing Date	Priority Date
1.	10,941038 Jensen	U.S.A.	Mar. 9, 2021	Feb. 2, 2017	Feb. 2, 2016

No.	Number and Name	Country of Origin	Issue Date/Date of Publication	Filing Date	Priority Date
2.	9,683,176 Christensen	U.S.A.	Jun. 20, 2017	Oct. 16, 2015	Oct. 16, 2015
3.	US2009/0298957 Gauthier	U.S.A.	Dec. 3, 2009	Oct. 27, 2005	Nov. 16, 2004
4.	US2002/0143219 Price	U.S.A.	Oct. 3, 2002	Jan. 25, 2002	Jul. 29, 1999
5.	9,353,022 Lindell	U.S.A.	May 31, 2016	Dec. 1, 2014	Dec. 2, 2013

Table 3: Publication Secondary References for the Asserted Patent

No.	Title	Date of Publication	Author(s) and Publisher
1.	Future Energy Efficiency and CO ₂ Reduction Potential	Mar 12-14, 2007	Svend Erik Nielsen (Topsoe) 2007 IFA International Conference, Ho Chi Minh City Vietnam

Topsoe further contends that there may be offers for sale and/or public uses of products that qualify as prior art under 35 U.S.C. § 102, including but not limited to the technology described in the prior art patents and publications identified herein and include prior art systems from Topsoe and others in the ammonia synthesis design field. Details regarding such offers for sale and public uses may be found within the identified prior art and/or the possession of Casale and/or third parties, their successors-in-interest, and their respective customers, from whom Topsoe has not yet received discovery. Topsoe reserves the right to present additional prior art or evidence of prior art located and to amend or supplement its Invalidity Contentions to the extent that such discovery or investigation yields information forming the basis for such contentions.

B. Whether Each Item of Prior Art Anticipates Each Asserted Claim or Renders it Obvious

Regarding Local Patent Rule 3-3, the exhibits hereto identify prior art that expressly or inherently anticipates each Asserted Claim, or that in combination expressly or inherently renders the Asserted Claims obvious, under either a proper claim construction or under Casale's erroneous application of the Asserted Claims to Topsoe. Motivations to modify or combine references are stated in the exhibits attached hereto, and/or are provided by discussions in the cited references, the state of the art discussed in the references, and the knowledge of a person of ordinary skill in the art.

Topsoe provides these disclosures without prejudice to any argument or objections concerning the relevance of motivation to combine and reserve the right to expand on these exemplary motivations to combine in its expert report(s).

Each of the prior art references charted in Exhibits A-1 through A-3 anticipates or renders obvious each Asserted Claim of the '168 Patent under 35 U.S.C. §§ 102, 103.

Table 4: Bases for Invalidity for the '168 Patent

Exhibit	'168 Claims	Bases for Invalidity
A-1	1, 5, 8, 9, 10, 18, and 19	§ 103 – IFFCO ammonia plant alone or in view of Jensen, Christensen, Gauthier, Price, Lindell, and/or Nielsen 2007.
A-2	1, 5, 8, 9, 10, 18, and 19	§ 103 – QAFCO ammonia plant alone or in view of Jensen, Christensen, Gauthier, Price, Lindell, and/or Nielsen 2007.
A-3	1, 5, 8, 9, 10, 18, and 19	§ 103 – Tata Babrala ammonia plant alone or in view of Jensen, Christensen, Gauthier, Price, Lindell, and/or Nielsen 2007.

Each of the prior art references charted in Exhibits A-1 through A-3 anticipates or renders obvious each Asserted Claim of the '168 Patent under 35 U.S.C. §§ 102, 103, and

it would have been obvious to a person of ordinary skill in the art to have modified or combined any of the prior art references charted with each other or to modify the references alone.

The references identified above under 35 U.S.C. §§ 102, 103, and in the claim charts attached hereto, are exemplary and are not exhaustive. Additional combinations of the references are possible. Topsoe reserves the right to use any such combinations in this action.

Casale has not identified any secondary considerations or other objective evidence of non-obviousness. Topsoe reserves its right to submit contentions and evidence to rebut any secondary considerations or other objective evidence that Casale may later identify.

C. A Chart Identifying Where Specifically in Each Item of Prior Art Each Element of Each Asserted Claim Is Found, Including for Each Element Governed by 35 U.S.C. § 112(f), the Identity of the Structure(s), Act(s), or Material(s) in Each Item of Prior Art that Performs the Claimed Function

Attached hereto as Exhibits A-1 through A-3 are claim charts identifying examples of where specifically in each item of prior art each element of each Asserted Claim is found. For each claim element found in an item of prior art, Topsoe has identified at least one instance of that element. Other instances may also exist but are not identified because of their duplicative nature. Topsoe does not contend that any limitations in the Asserted Claims are governed by 35 U.S.C. § 112(f) (pre-AIA § 112(6)).

Topsoe bases these claim charts in part upon the infringement positions taken by Casale. These claim charts in no way indicate that Topsoe agrees with or adopts Casale's positions or claim constructions. Topsoe reserves the right to propose and argue for

different positions and different constructions of the claim language. Nothing herein should be construed as setting forth or limiting Topsoe's claim construction positions. To the extent that any of the prior art references discloses the same feature or functionality of the accused instrumentalities, Topsoe reserves the right to argue that such feature or functionality does not meet any limitation of any of the Asserted Claims of the Asserted Patent.

D. Any Grounds of Invalidity Based on Indefiniteness under 35 U.S.C. § 112(b) or Enablement or Written Description under 35 U.S.C. § 112(a) of any of the Asserted Claims

At this time, Topsoe does not identify any Asserted Claims or claim limitations as indefinite or failing to meet enablement or written description. Topsoe specifically reserves the right to amend and/or supplement these Invalidity Contentions to assert additional Section 112 defenses as it learns more about Casale's Infringement Contentions, including in the event Casale supplements or amends its Infringement Contentions, and based on information obtained during discovery, Casale's proposed claim constructions, any claim constructions given by the Court, or any position taken by Casale or its expert(s). To the extent the claim term discussed below is addressed in the invalidity charts or contentions herein, Topsoe has not waived the arguments herein and has merely analyzed the claim in the event it is not held invalid. Topsoe expressly reserves the right to assert indefiniteness, lack of enablement, or lack of written description for any claim or claim limitation as to which Casale proposes a construction that would, if accepted, expand the scope of the claim beyond the disclosure of the specification.

E. Document Production Accompanying Invalidity Contentions

Pursuant to Local Patent Rule 3-4, Topsoe is required to “produce or make available for inspection and copying” documents or evidence showing “the operation of any aspects or elements of an Accused Instrumentality identified by the patent claimant in its P.R. 3-1(c) chart.” However, because the Asserted Claims are all method claims, they can only be infringed by an accused infringer performing all the steps of the method within the United States. *See, e.g., Akamai Tech., Inc. v. Limelight Networks, Inc.*, 797 F.3d 1020, 1022 (Fed. Cir. 2015) (en banc); Dkts. 195, 205. In Casale’s P.R. 3-1(c) chart, Casale does not identify any Accused Instrumentality plant or facility that is being operated within the United States.

Topsoe has conducted a reasonable investigation and has not identified any plant or facility, including pilot plants or test plants, that has been operated within the United States using a Topsoe SynCOR™ ammonia process or other Topsoe ammonia synthesis process with an ATR and a pre-reformer without a primary reformer therebetween with a CO₂-depleted syngas stream that is split into two streams of the same composition with one stream fed as fuel to a furnace and the other intended for ammonia synthesis.

Because Casale has not identified any plant or facility as an Accused Instrumentality and Topsoe’s own investigation has not identified any U.S. plant operating using the accused process, i.e., SynCOR™, within the United States, there are no documents to produce that could reflect the operation of any Accused Instrumentality. If Casale identifies a SynCOR™ ammonia plant with an ATR and a pre-reformer without a primary reformer

therebetween with a CO₂-depleted syngas stream that is split into two streams of the same composition with one stream fed as fuel to a furnace and the other intended for ammonia synthesis within the United States as allegedly infringing, Topsoe will search for and produce all relevant documents within its custody and control reflecting the design and intended operation of such a plant or facility.

Dated: April 29, 2026

Respectfully submitted,

/s/ Jeffrey A. Andrews

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Counsel for Topsoe, Inc. and Topsoe A/S

CERTIFICATE OF SERVICE

I certify that on April 29, 2026, a true and correct copy of the foregoing was served on the counsel of record through the Court's electronic filing system.

/s/ Jeffrey A. Andrews

Jeffrey A. Andrews

Exhibit A-01**Invalidity Chart for U.S. Patent No. 11,286,168 (the “’168 Patent”) Based on the IFFCO Aonla-1 Ammonia Plant in India as the primary reference**

IFFCO licensed Topsoe ammonia synthesis technology to build and operate the Aonla-1 ammonia synthesis plant in India. IFFCO has been operating the plant since the around the 1980s, with Topsoe process drawings for the Aonla-1 plant bearing dates of 1985. The IFFCO Aonla-1 ammonia synthesis plant is therefore prior art to the ’168 patent at least because it reflects a process that was known and used by others and was “on sale” under post-AIA 35 U.S.C. § 102(a).

Secondary references included herein are prior art under post-AIA 35 U.S.C. § 102(a) as listed in the chart below.

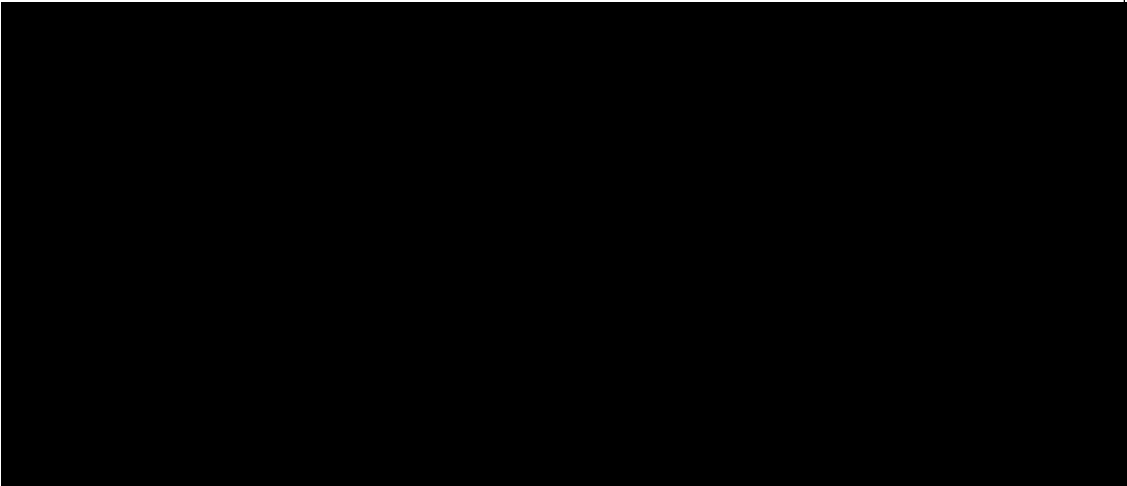
No.	Number and Name	Type of Art	Prior Art Dates
1.	10,941,038 Jensen	Patent	Mar. 9, 2021
2.	9,683,176 Christensen	Patent	Jun. 20, 2017
3.	US2009/0298957 Gauthier	Patent App.	Dec. 3, 2009
4.	US2002/0143219 Price	Patent App.	Oct. 3, 2002
5.	“Future Energy Efficiency and CO ₂ Reduction Potential,” presented by Svend Erik Nielsen (Topsoe A/S) at 2007 IFA International Conference (“Nielsen 2007”).	Publication	Apr. 2007
6.	U.S. Pat. No. 9,353,022 to Lindell, et al. (“Lindell”).	Patent	Dec. 2, 2013

General Motivation to Combine IFFCO with one or more of Jensen, Christensen, Gauthier, Price, Lindell, and/or Nielsen 2007:

A POSA in the technical field of syngas production would have had a reasonable expectation of success in modifying the IFFCO ammonia synthesis plant to incorporate the pre-reformer-ATR process design disclosed in one or more of Jensen, Christensen, Gauthier, Price, Lindell, and/or Nielsen 2007. Such modifications would have been obvious because of the similar technologies involved, well-known and commonly used processes disclosed, commercial and financial motivations provided by such combinations, and/or a desire to reduce carbon emissions. For example, a POSA would readily understand that IFFCO’s use of a [REDACTED] would be equally applicable (and with a high expectation of success) to at least partially fuel the pre-heating of the pre-reformer of

Ex. A-01

Jensen, Christensen, Gauthier, Price, Lindell, and/or Nielsen 2007 or for steam generation and/or superheating. Such modifications would have been selected from a finite number of identified means for generating syngas for downstream applications, including for example, ammonia synthesis. A POSA's motivations to make such modifications would also be part of routine optimization, design choices, addressing known problems in the art, responding to market pressures, and applying known principles and techniques.

Claims	Exemplary Citations
1p A process for synthesis of ammonia from natural gas, the process comprising:	The IFFCO Aonla-1 ammonia synthesis plant performs a process for synthesis of ammonia from natural gas.  TOPSOE_0018096 at 098. 

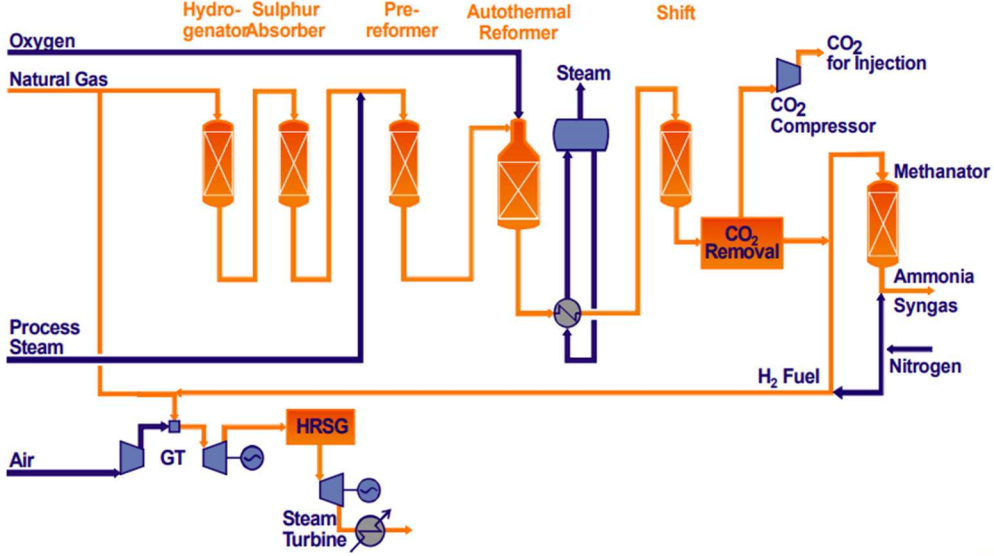
Claims	Exemplary Citations
	TOPSOE_0018096 at 097. [REDACTED] [REDACTED] TOPSOE_0018096 at 097-98.
1a conversion of a charge of desulphurized natural gas and steam, with oxygen-enriched air or with oxygen, into a synthesis gas containing hydrogen, CO and CO₂, in a conversion section including an autothermal reformer downstream from a pre-reformer and without a primary reformer therebetween;	The IFFCO Aonla-1 ammonia synthesis plant includes or it would have been obvious to a POSA to include a process step of converting a charge of desulphurized natural gas and steam with oxygen-enriched air or with oxygen, into a synthesis gas containing hydrogen, CO and CO₂, in a conversion section include an autothermal reformer downstream from a pre-reformer and without a primary reformer therebetween. [REDACTED] TOPSOE_0018096 at 097. [REDACTED] [REDACTED] [REDACTED]

Claims	Exemplary Citations
	TOPSOE_0018096 at 097.

Claims	Exemplary Citations
	TOPSOE_0018096 at 097-98. It would have been obvious to a POSA as of 2017 to replace the desulphurized natural gas and air fed primary reformer and secondary reformer with an enriched air or oxygen fed autothermal reformer with a pre-reformer without a primary reformer therebetween. The POSA would have been motivated to make such a substitution because ammonia processes with autothermal reformers with a pre-reformer without a primary reformer therebetween was a well-known process configuration. Such a configuration offers the benefit of reducing CO₂

Claims	Exemplary Citations
	emissions and reduced capital costs from reducing the size of the equipment required at least because of their lower S/C ration operation window, which would be goals of the POSA. ATRs are also well known to be fed with oxygen-enriched air or oxygen to optimize performance of the ATR and the reactions taking place therein. The POSA would have had a reasonable expectation of success in modifying the IFFCO process to use an ATR and pre-reformer without a primary reformer therebetween also because such a configuration was well-known and had been shown to be successful in synthesis of ammonia while reducing carbon emissions. A POSA would know that before 2017, ATRs had become “the preferred route to synthesis gas” for processes such as ammonia synthesis. Syngas Production [TOPSOE_0028153 at 215-218]. Thus, the POSA would have been motivated to modify IFFCO Aonla-1 itself or in combination with one or more of the references discussed below. Additionally, a POSA would readily understand that IFFCO’s use of [REDACTED] [REDACTED] would be equally applicable (and with a high expectation of success) to at least partially fuel the pre-heating of the pre-reformer of Jensen, Christensen, Gauthier, Price, Lindell, and/or Nielsen 2007 or for steam generation and/or superheating. Jensen The combination of IFFCO Aonla-1 with Jensen renders obvious the conversion section including an autothermal reformer downstream from a pre-reformer and without a primary reformer therebetween. Jensen discloses a syngas process of natural gas and an oxygen fed autothermal reformer with a pre-reformer without a primary reformer therebetween. <i>E.g.</i>, Jensen 3:13-29 (ATR feed mixed with oxygen and steam to produce syngas of CO, CO₂, and H₂), 3:66-4:10 (pre-reformer upstream of an ATR). Jensen discloses production of ammonia synthesis gas designed to be cost efficient, have high reliability, improve energy

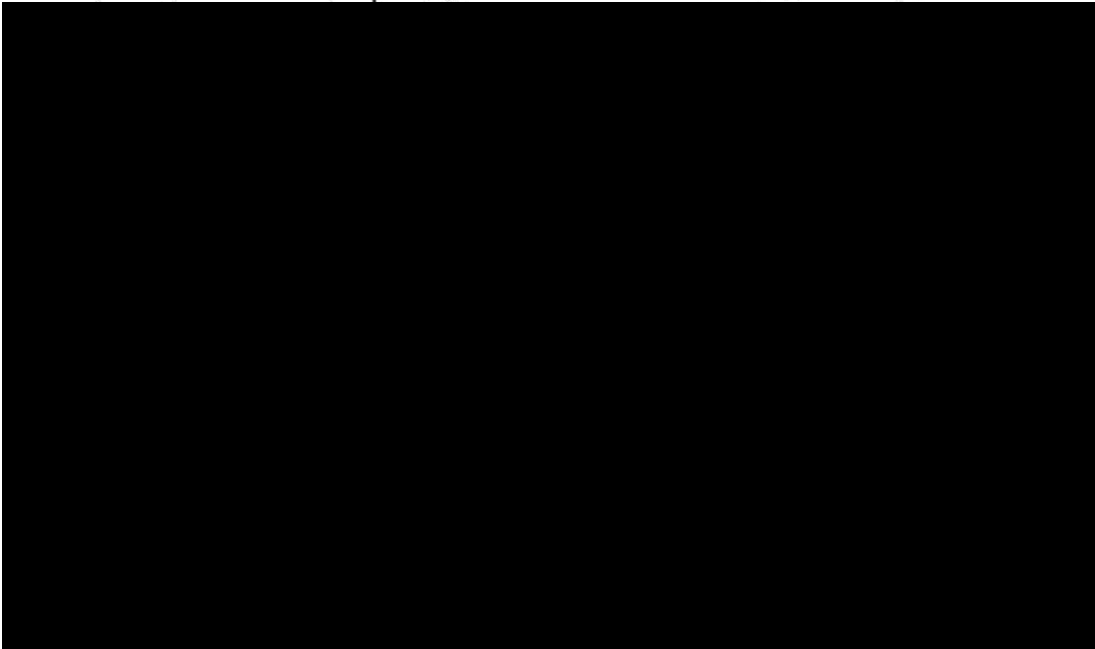
Claims	Exemplary Citations
	efficiency, and reduce capital case. Jensen 1:6-22, 2:43-47. The synthesis gas contains CO, CO₂, and hydrogen. The POSA would know of the use of ATRs produce syngas for ammonia synthesis and would have known to combine IFFCO Aonla-1 with Jensen with the expectation of success and to achieve the design improvements in an ammonia synthesis process. Nielsen 2007 The combination of IFFCO Aonla-1 with Nielsen 2007 renders obvious the conversion section including an autothermal reformer downstream from a pre-reformer and without a primary reformer therebetween. Nielsen 2007 discloses a syngas process of natural gas and an oxygen fed autothermal reformer with a pre-reformer without a primary reformer therebetween. <i>E.g.</i>, Nielsen 2007 [TOPSOE_0030113]. Nielsen 2007 discloses an ammonia synthesis process designed to reduce energy consumption, increase plant capacity, reduce carbon dioxide, and reduce equipment sizes to save on capital. Nielsen 2007 [TOPSOE_0030113 at 13, 15, 19-22]. The synthesis gas contains CO, CO₂, and hydrogen. The Nielsen 2007 presentation shows a process configuration with oxygen and steam, with desulphurized natural gas, fed into an ATR with a pre-reformer without a primary reformer therebetween to produce syngas.

Claims	Exemplary Citations
	 [TOPSOE_0030113 at 21]. The POSA would know of the use of ATRs produce syngas for ammonia synthesis and would have known to combine IFFCO Aonla-1 with Nielsen 2007 with the expectation of success and to achieve the design improvements in an ammonia synthesis process. Lindell The combination of IFFCO Aonla-1 with Lindell renders obvious the conversion section including an autothermal reformer downstream from a pre-reformer and without a primary reformer therebetween. Lindell discloses a syngas process of natural gas and an oxygen fed autothermal reformer with a pre-reformer without a primary reformer therebetween. <i>E.g.</i>, Lindell 2:17-22, 3:3-12, 3:42-44, 4:2-12, 4:14-29, 5:11-21, 5:49-5:66. The synthesis gas contains CO, CO₂, and hydrogen.

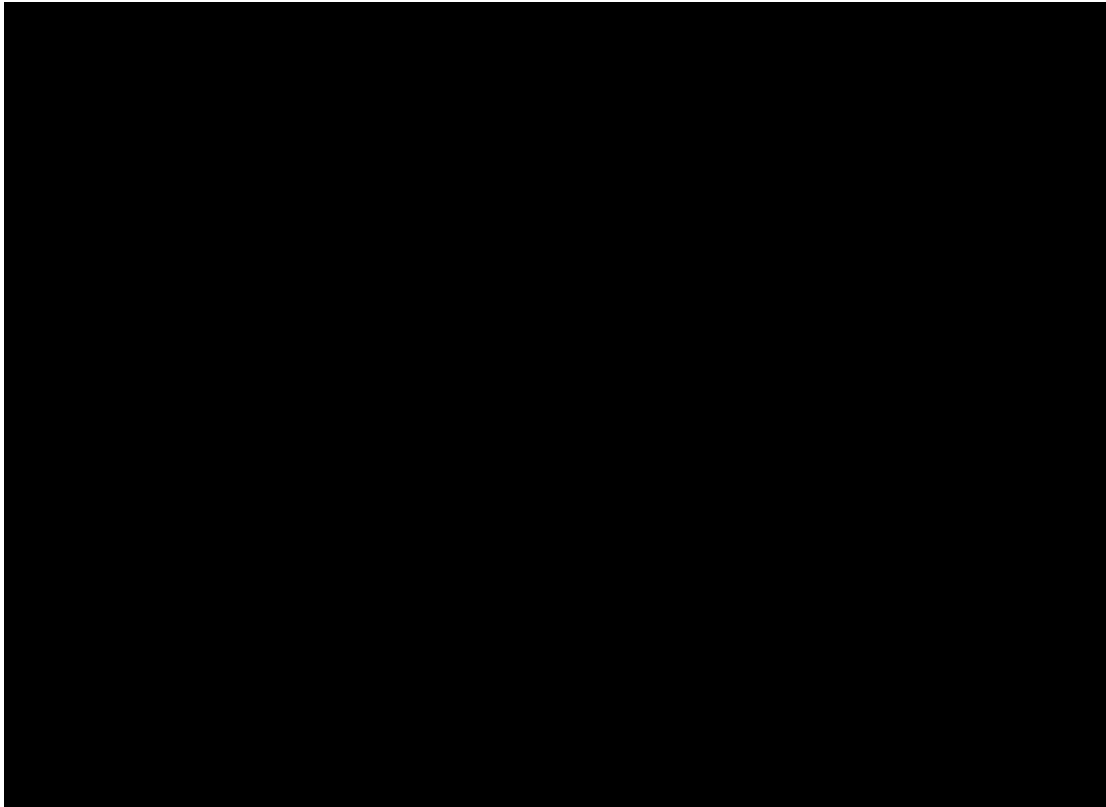
Claims	Exemplary Citations
	Lindell 3:12-15. Despite Lindell disclosing its process for use in GTL plants, the use of ATRs produce syngas for ammonia synthesis would have been well known to the POSA and the POSA would expect success combining Lindell with the ammonia synthesis process of IFFCO Aonla-1. <i>See, e.g.</i>, Syngas Production [TOPSOE_0028153 at 215-16, 221-223]. Indeed, Lindell recognizes that similar processes for CO₂ removal would be used on the syngas for ammonia synthesis that are not necessary for GTL processes. Lindell 1:52-61, 7:33-37. Gauthier The combination of IFFCO Aonla-1 with Gauthier renders obvious the conversion section including an autothermal reformer downstream from a pre-reformer and without a primary reformer therebetween. Gauthier discloses an ammonia syngas production process using natural gas and an oxygen fed autothermal reformer with a pre-reformer without a primary reformer therebetween. <i>E.g.</i>, Gauthier ¶¶ 1-3, 11, 75, 85. The synthesis gas contains CO, CO₂, and hydrogen. The POSA would know of the use of ATRs produce syngas for ammonia synthesis and would have known to combine IFFCO Aonla-1 with Gauthier with the expectation of success and to achieve the design improvements in an ammonia synthesis process. Price The combination of IFFCO Aonla-1 with Price renders obvious the conversion section including an autothermal reformer downstream from a pre-reformer and without a primary reformer therebetween. Price discloses a syngas ammonia process of natural gas and an oxygen fed autothermal reformer without a primary reformer therebetween. <i>E.g.</i>, Price ¶¶ 7, 14, 39, 59-65. The POSA would know that depending on the makeup of the natural gas feed to the process, a pre-

Claims	Exemplary Citations
	reformer may be desirable before the ATR. Price teaches an ammonia process that reduces CO₂ emissions. Price Abstract, ¶ 21. The synthesis gas contains CO, CO₂, and hydrogen. The POSA would know of the use of ATRs produce syngas for ammonia synthesis and would have known to combine IFFCO Aonla-1 with Price with the expectation of success and to achieve the design improvements in an ammonia synthesis process. Christensen The combination of IFFCO Aonla-1 with Christensen renders obvious the conversion section including an autothermal reformer downstream from a pre-reformer and without a primary reformer therebetween. Christensen discloses a syngas process of natural gas and an oxygen fed autothermal reformer with a pre-reformer without a primary reformer therebetween. <i>E.g.</i>, Christensen 1:13-22 (at least 80% vol. O₂ into an autothermal reformer with a pre-reformer to produce syngas), 29-33 (well known to use ATR fed with natural gas to produce syngas). The synthesis gas contains CO, CO₂, and hydrogen. Despite Christensen disclosing its process for use in GTL plants, the use of ATRs produce syngas for ammonia synthesis would have been well known to the POSA and the POSA would expect success combining Christensen with the ammonia synthesis process of IFFCO Aonla-1. <i>See, e.g.</i>, Syngas Production [TOPSOE_0028153 at 215-16, 221-223].
1b treatment of said synthesis gas including at least a shift reaction of the carbon monoxide into CO₂, and subsequent separation of CO₂ from the gas, thus obtaining a CO₂-depleted synthesis gas	The IFFCO Aonla-1 ammonia synthesis plant treats the syngas with a shift reaction of CO into CO₂ with the CO₂ subsequently separated from the syngas to create a CO₂ rich gas flow and a CO₂-depleted syngas stream.

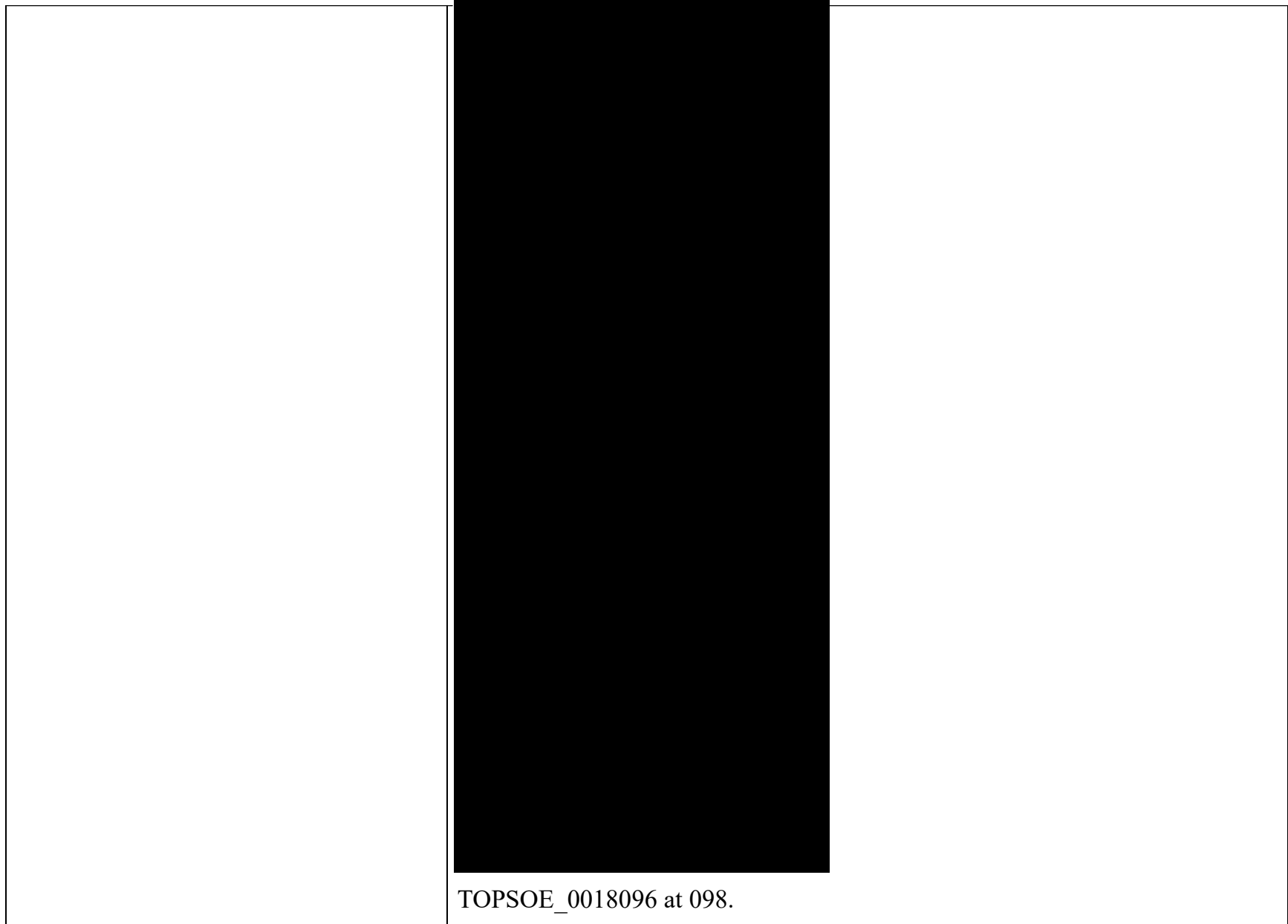
Claims	Exemplary Citations
and a CO₂-rich gaseous flow containing the CO₂ separated from the gas;	TOPSOE_0018096 at 099.

Claims	Exemplary Citations
	 TOPSOE_0018096 at 100.

Claims	Exemplary Citations
	TOPSOE_0018096 at 100. TOPSOE_0018096 at 100.

Claims	Exemplary Citations
1c separation of a part of said CO₂-depleted synthesis gas as fuel fraction, wherein said fuel fraction is fed as fuel to at least one furnace and wherein said separation of the fuel fraction includes the split of said CO₂-depleted synthesis gas into at least a first stream and a second stream, said first and second streams having the same composition, wherein the first stream forms the fuel fraction and the second stream is process gas intended for the synthesis of ammonia.	The IFFCO Aonla-1 ammonia synthesis plant CO₂-depleted syngas stream [6] is separated into a first and second stream with the first stream is used as a fuel fraction that is fed as fuel to at least one furnace and the second stream is process gas intended for the synthesis of ammonia with the first and second stream having the same composition.  TOPSOE_0018096 at 100.

Ex. A-01



ATTORNEYS' EYES ONLY

Claims	Exemplary Citations
	The POSA would also know that when the primary reformer and secondary reformer and replaced with a pre-reformer and ATR without a primary reformer (see limitation 1a, above), that the syngas used as fuel would be used to preheat the natural gas feed to the pre-reformer and/or ATR or to generate and/or superheat steam to support the ammonia synthesis process. The POSA would also recognize, be motivated to, and would expect success in using the syngas as fuel to reduce the carbon emissions from the process.
5 The process of claim 1, further comprising a step for methanation of the synthesis gas and/or addition of nitrogen to the synthesis gas.	The IFFCO Aonla-1 ammonia synthesis plant includes a step for methanation of the syngas in a methanator [R-1311] in the process flow of the syngas.

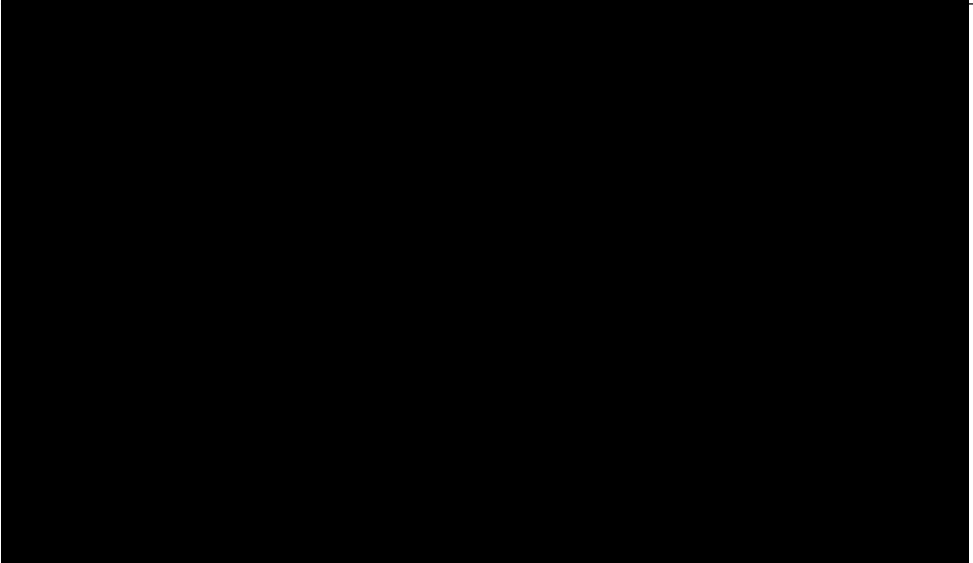
Claims	Exemplary Citations
	TOPSOE-0018096 at 100.

Claims	Exemplary Citations
8 The process of claim 1, wherein said enriched air contains at least 50% oxygen.	It would have been obvious to a POSA, as of 2017 once replacing the desulphurized natural gas and air fed primary reformer and secondary reformer with an enriched air or oxygen fed autothermal reformer with a pre-reformer without a primary reformer therebetween, to use enriched air at least 50% oxygen. The POSA would understand that ATRs are well-known to be fed with oxygen-enriched air or oxygen to optimize performance of the ATR and the reactions taking place therein. The POSA would understand that a stream of oxygen is a stream of enriched air with at least 50% oxygen. The use of enriched air of at least 50% oxygen is a part of the normal design choices the POSA make in designing and operating the ammonia synthesis process. Thus, the POSA would have been motivated to modify IFFCO Aonla-1 or to combine it with one or more of the references discussed below. Jensen Jensen Figure 2 shows “oxygen” being fed into the ATR. Jensen discloses that the feed for the ATR “is mixed with oxygen and additional steam.” Jensen 2:12-25. Jensen discloses using air being fed into an air separation unit (ASU) to convert the air into oxygen for use in the ATR. Jensen 5:24-28. Nielsen 2007 The Nielsen 2007 discloses an oxygen feed into the ATR. Nielsen 2007 [TOPSOE_0030113 at 21].

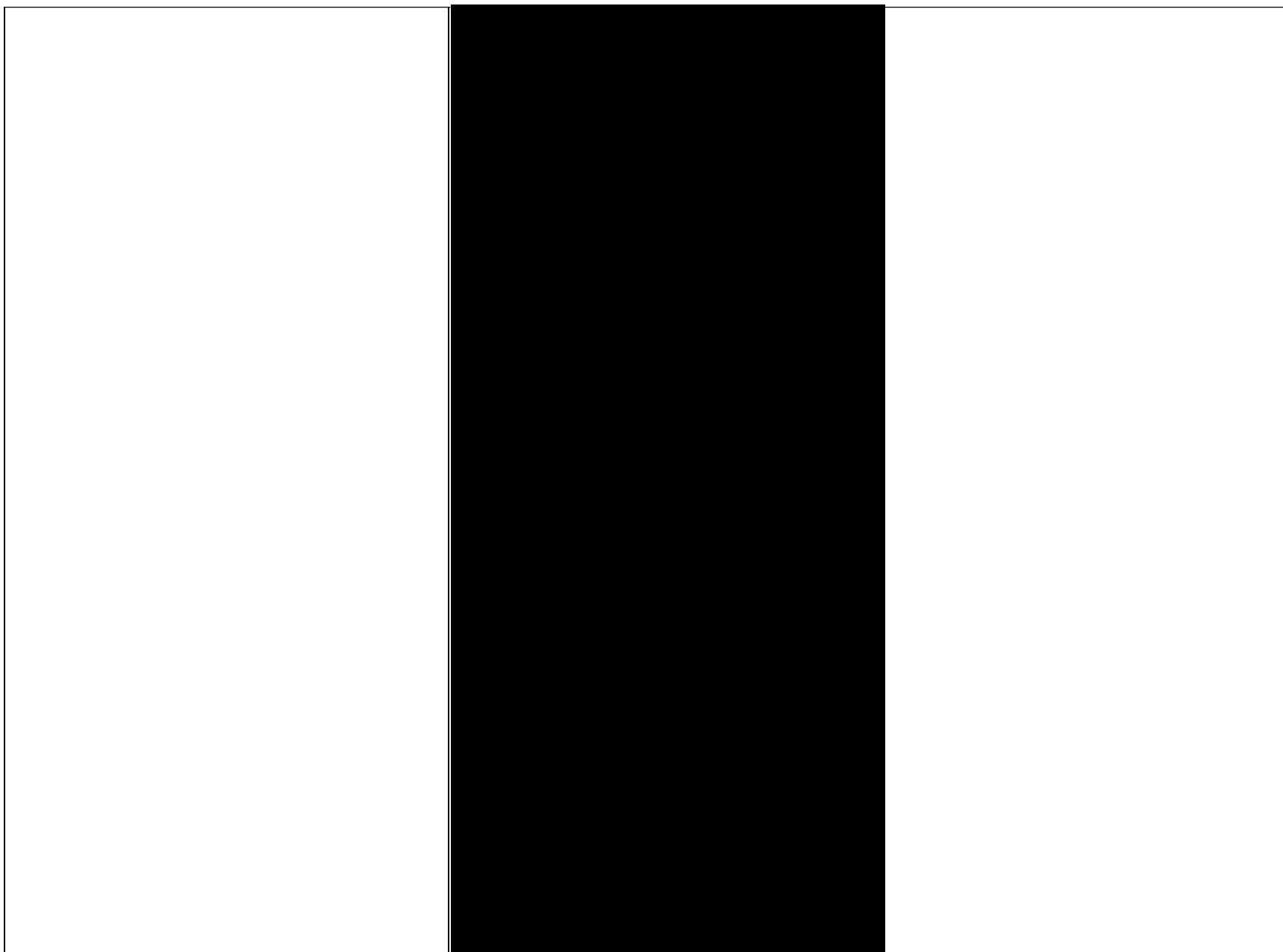
Claims	Exemplary Citations
	Lindell Lindell discloses feeding the ATR with “enriched air or oxygen.” Lindell 4:20-29; <i>see id.</i> at 2:19-22, 2:50-61, 3:65-4:11, 4:49-59, 5:8-21. Gauthier Gauthier discloses the use of an autothermal reformer. Gauthier ¶¶ 11, 43, 75. The POSA would understand that ATRs are well-known to be fed with oxygen-enriched air or oxygen to optimize performance of the ATR and the reactions taking place therein. Price Price discloses air being fed into an air separation unit to then feed oxygen into an autothermal reformer. Price ¶¶ 4, 38-39. Christensen Christensen teaches that feeding an ATR with oxygen of at least 80% vol. and most preferably at least 95% vol. Christensen 1:10-19, 2:7-18.
9 The process of claim 1, wherein said enriched air contains at least 90% oxygen.	It would have been obvious to a POSA, as of 2017 once replacing the desulphurized natural gas and air fed primary reformer and secondary reformer with an enriched air or oxygen fed autothermal reformer with a pre-reformer without a primary reformer therebetween, to use enriched air at least 90% oxygen. The POSA would understand that ATRs are well-known to be fed with oxygen-enriched air or oxygen to optimize performance of the ATR and the reactions taking place therein. The POSA would understand that a stream of oxygen is a stream of enriched air with at least 90% oxygen. The use of enriched

Claims	Exemplary Citations
	air of at least 90% oxygen is a part of the normal design choices the POSA make in designing and operating the syngas/ammonia synthesis process. Thus, the POSA would have been motivated to modify IFFCO Aonla-1 or combine it with one or more of the references discussed below. Jensen Jensen Figure 2 shows “oxygen” being fed into the ATR. Jensen discloses that the feed for the ATR “is mixed with oxygen and additional steam.” Jensen 2:12-25. Jensen discloses using air being fed into an air separation unit (ASU) to convert the air into oxygen for use in the ATR. Jensen 5:24-28. Nielsen 2007 Nielsen 2007 includes a figure that shows “oxygen” being fed into an ATR. Nielsen 2007 [TOPSOE_0030113 at 21]. Lindell Lindell discloses feeding the ATR with “enriched air or oxygen.” Lindell 4:20-29; <i>see id.</i> at 2:19-22, 2:50-61, 3:65-4:11, 4:49-59, 5:8-21. Gauthier Gauthier discloses the use of an autothermal reformer. Gauthier ¶¶ 11, 43, 75. The POSA would understand that ATRs are well-known to be fed with oxygen-enriched air or oxygen to optimize performance of the ATR and the reactions taking place therein.

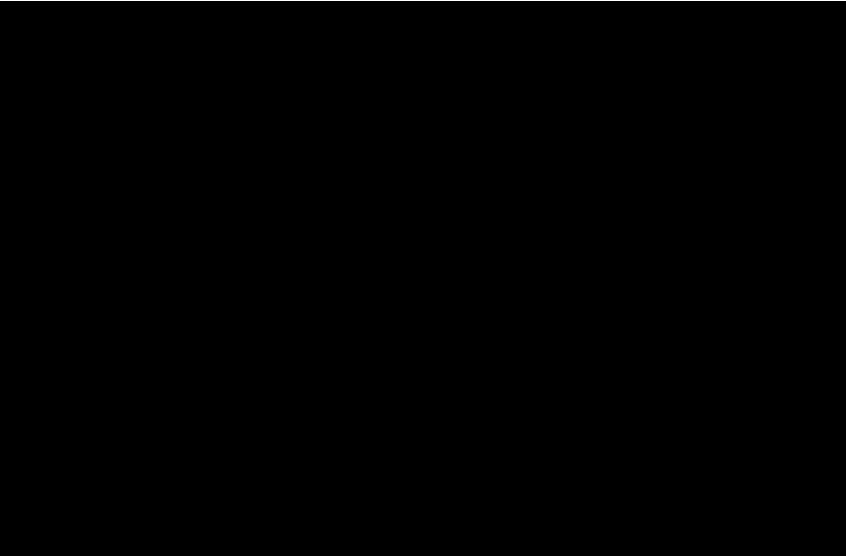
Claims	Exemplary Citations
	Price Price discloses air being fed into an air separation unit to then feed oxygen into an autothermal reformer. Price ¶¶ 4, 38-39. Christensen Christensen teaches that feeding an ATR with oxygen of at least 80% vol. and most preferably at least 95% vol. Christensen 1:10-19, 2:7-18.
10 The process of claim 1, wherein said fuel fraction of the synthesis gas feeds one or more of the following apparatuses: a steam production and/or superheating furnace; or one or more furnaces for pre-heating the charge of the autothermal reformer or natural-gas desulphurization section.	The IFFCO Aonla-1 ammonia synthesis plant CO₂-depleted syngas stream is separated into a first and second stream with the first stream is used as a fuel fraction that is fed as fuel to one or more of a steam production and/or superheating furnace; or one or more furnaces for pre-heating the charge of the autothermal reformer or natural-gas desulphurization section.

Claims	Exemplary Citations
	 TOPSOE_0018096 at 100.

Ex. A-01



ATTORNEYS' EYES ONLY

Claims	Exemplary Citations
	TOPSOE_0018096 at 098. The POSA would also know that when the primary reformer and secondary reformer and replaced with a pre-reformer and ATR without a primary reformer (see limitation 1a, above), that the syngas used as fuel would be used to preheat the natural gas feed to the pre-reformer and/or ATR or to generate and/or superheat steam to support the ammonia synthesis process. The POSA would also recognize and be motivated to and expect success using the syngas as fuel to reduce the carbon emissions from the process.
18 The process of claim 1, wherein the fuel fraction is produced in excess with respect to the fuel necessary for the conversion section, the quantity of said fuel fraction exceeding that required being exported from the process; and regulation of the conversion section is performed by modulating the quantity of said fuel fraction directed towards the conversion section and the quantity exported from the process.	The IFFCO Aonla-1 ammonia synthesis plant PFDs show a CO₂-depleted syngas stream used as a fuel [7] in the conversion section.  TOPSOE_0018096 at 100.

Claims	Exemplary Citations
	TOPSOE_0018096 at 098.

Claims	Exemplary Citations
	The POSA would know that flow rate of surplus syngas produced and recycled to the conversion section or exported from the process is a design decision and selecting operating window such that excess syngas is produced would be obvious.
19 The process of claim 1, wherein: conversion of the charge of desulphurized natural gas and steam into the synthesis gas in the autothermal reformer is performed with a steam/carbon ratio not greater than 2.	It would have been obvious to a POSA, as of 2017, to operate the ATR with a steam/carbon ratio not greater than 2. The POSA would know that ATRs typically operate at a lower S/C ratio than traditional ammonia synthesis using primary reformers (e.g., steam methane reformers (SMRs)). The POSA would have been motivated to modify IFFCO Aonla-1 or to combine it with one or more of the references discussed below. Jensen Jensen teaches that S/C ratios using an ATR can be as low as 0.3 and that lower S/C ratios with an ATR allows smaller equipment, capital savings, and higher syngas throughput. Jensen 2:5-10, 2:30-43, 3:8-11, 6:62-67. Jensen expressly discloses “The steam/carbon ratio in the reforming section may be 2.6-0.1, 2.4-0.1, 2-0.2, 1.5-0.3, 1.4-0.4, such as 1.2, 1.0 or 0.6.” Jensen 3:41-43. Nielsen 2007 The POSA would know that the operating range for the S/C is a design decision and selecting operating window based on design goals, including equipment sizing and carbon emissions. It would be obvious to select a S/C ratio less than two while using a pre-reformer and ATR as part of an ammonia synthesis process. Lindell

Claims	Exemplary Citations
	Lindell discloses operating the ATR and that operating they are “preferably operated at low S/C ratios.” Lindell 2:4-15, 3:3-12, 4:57-63, 6:44-54, <i>see id.</i> 6:40-48. Lindell also teaches that feed of natural gas and steam can be adjusted to “obtain the desired steam-to-carbon (S/C) ratio.” Lindell 2:37-50. The POSA would know that the operating range for the S/C is a design decision and selecting operating window based on design goals, including equipment sizing and carbon emissions. It would be obvious to select a S/C ratio less than two while using a pre-reformer and ATR as part of an ammonia synthesis process. Gauthier Gauthier discloses the use of an autothermal reformer and the reduction of the S/C ratio. Gauthier ¶ 10. The POSA would know that the operating range for the S/C is a design decision and selecting operating window based on design goals, including equipment sizing and carbon emissions. It would be obvious to select a S/C ratio less than two while using a pre-reformer and ATR as part of an ammonia synthesis process. Price Price discloses the use of an autothermal reformer operating “with a steam/reformable carbon ratio of 0.6.” Price ¶¶ 43, 59. The POSA would know that the operating range for the S/C is a design decision and selecting operating window based on design goals, including equipment sizing and carbon emissions. It would be obvious to select a S/C ratio less than two while using a pre-reformer and ATR as part of an ammonia synthesis process. Christensen

Claims	Exemplary Citations
	Christensen discloses the use of an autothermal reformer. Christensen 1:10-19, 2:7-18. The POSA would know that the operating range for the S/C is a design decision and selecting operating window based on design goals, including equipment sizing and carbon emissions. It would be obvious to select a S/C ratio less than two while using a pre-reformer and ATR as part of an ammonia synthesis process

Exhibit A-02**Invalidity Chart for U.S. Patent No. 11,286,168 (the “168 Patent”) Based on the QAFCO Ammonia Plant in Qatar as the primary reference**

QAFCO licensed Topsoe ammonia synthesis technology to build and operate an ammonia synthesis plant in Qatar by the Qatar Fertiliser Co. The QAFCO plant has been operating since around 2014, when Topsoe and QAFCO agreed that the plant met the performance guarantees of the parties’ agreement. [TOPSOE_0029869]. The QAFCO ammonia synthesis plant is therefore prior art to the ’168 patent at least because it reflects a process that was known and used by others and was “on sale” under post-AIA 35 U.S.C. § 102(a).

Secondary references included herein are prior art under post-AIA 35 U.S.C. § 102(a) as listed in the chart below.

No.	Number and Name	Type of Art	Prior Art Dates
1.	10,941,038 Jensen	Patent	Mar. 9, 2021
2.	9,683,176 Christensen	Patent	Jun. 20, 2017
3.	US2009/0298957 Gauthier	Patent App.	Dec. 3, 2009
4.	US2002/0143219 Price	Patent App.	Oct. 3, 2002
5.	“Future Energy Efficiency and CO ₂ Reduction Potential,” presented by Svend Erik Nielsen (Topsoe A/S) at 2007 IFA International Conference (“Nielsen 2007”).	Publication	Apr. 2007
6.	U.S. Pat. No. 9,353,022 to Lindell, et al. (“Lindell”).	Patent	Dec. 2, 2013

General Motivation to Combine QAFCO with one or more of Jensen, Christensen, Gauthier, Price, Lindell, and/or Nielsen 2007:

A POSA in the technical field of syngas production would have had a reasonable expectation of success in modifying the QAFCO ammonia synthesis plant to incorporate the pre-reformer-ATR process design disclosed in one or more of Jensen, Christensen, Gauthier, Price, Lindell, and/or Nielsen 2007. Such modifications would have been obvious because of the similar technologies involved, well-known and commonly used processes disclosed, commercial and financial motivations provided by such combinations, and/or a desire to reduce carbon emissions. For example, a POSA would readily understand that QAFCO’s use of a [REDACTED] would be

equally applicable (and with a high expectation of success) to at least partially fuel the pre-heating of the pre-reformer of Jensen, Christensen, Gauthier, Price, Lindell, and/or Nielsen 2007 or for steam generation and/or superheating. Such modifications would have been selected from a finite number of identified means for generating syngas for downstream applications, including for example, ammonia synthesis. A POSA's motivations to make such modifications would also be part of routine optimization, design choices, addressing known problems in the art, responding to market pressures, and applying known principles and techniques.

Claims	Exemplary Citations
1p A process for synthesis of ammonia from natural gas, the process comprising:	The QAFCO ammonia synthesis plant performs a process for synthesis of ammonia from natural gas.  TOPSOE_0029861.

Claims	Exemplary Citations
1a conversion of a charge of desulphurized natural gas and steam, with oxygen-enriched air or with oxygen, into a synthesis gas containing hydrogen, CO and CO₂, in a conversion section including an autothermal reformer downstream from a pre-reformer and without a primary reformer therebetween;	The QAFCO ammonia synthesis plant includes or it would have been obvious to a POSA to include a process step of converting a charge of desulphurized natural gas and steam with oxygen-enriched air or with oxygen, into a synthesis gas containing hydrogen, CO and CO₂, in a conversion section include an autothermal reformer downstream from a pre-reformer and without a primary reformer therebetween.

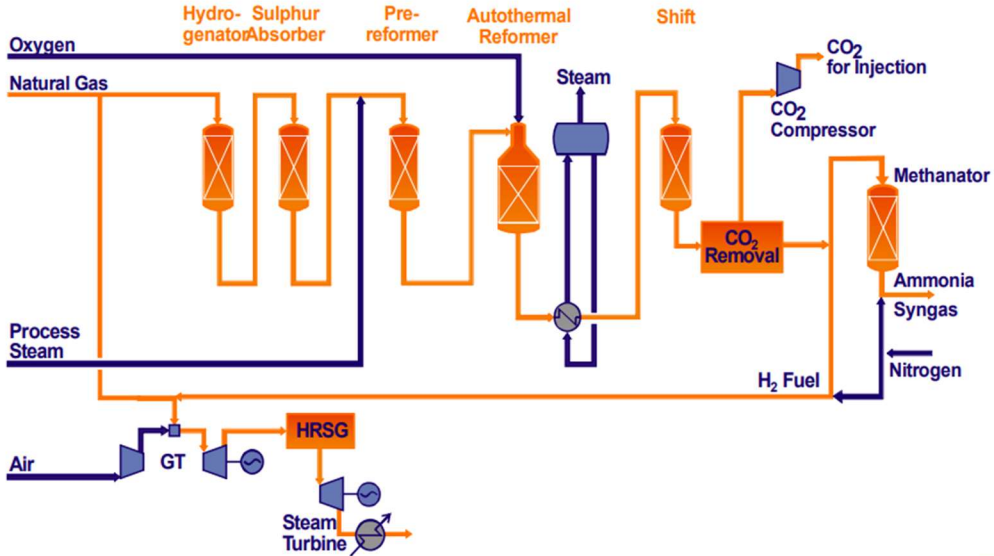
Claims	Exemplary Citations
	TOPSOE_0029861. TOPSOE_0029861.

Claims	Exemplary Citations
	 TOPSOE_0029861.

Claims	Exemplary Citations
	TOPSOE_0029861. TOPSOE_0029861. It would have been obvious to a POSA as of 2017 to replace the desulphurized natural gas and air fed primary reformer and secondary reformer with an enriched air or oxygen fed autothermal reformer with a pre-reformer without a primary reformer therebetween. The POSA would have been motivated to make such a substitution because ammonia processes with autothermal reformers with a pre-reformer without a primary reformer therebetween was a well-known process configuration. Such a configuration offers the benefit of reducing CO₂ emissions and reduced capital costs from reducing the size of the equipment required at least because of their lower S/C ration operation window, which would be goals of the POSA. ATRs are also well known to be fed with oxygen-enriched air or oxygen to optimize performance of the ATR and the reactions taking place therein. The POSA would have had a reasonable expectation of success in modifying the QAFCO process to use an ATR and pre-reformer without a primary reformer therebetween also because such a configuration was

Claims	Exemplary Citations
	well-known and had been shown to be successful in synthesis of ammonia while reducing carbon emissions. A POSA would know that before 2017, ATRs had become “the preferred route to synthesis gas” for processes such as ammonia synthesis. Syngas Production [TOPSOE_0028153 at 215-218]. Thus, the POSA would have been motivated to modify QAFCO itself or in combination with one or more of the references discussed below. Additionally, a POSA would readily understand that QAFCO’s use of a CO₂-depleted syngas stream to at least partially fuel [REDACTED] would be equally applicable (and with a high expectation of success) to at least partially fuel the pre-heating of the pre-reformer of Jensen, Christensen, Gauthier, Price, Lindell, and/or Nielsen 2007 or for steam generation and/or superheating. Jensen The combination of QAFCO with Jensen renders obvious the conversion section including an autothermal reformer downstream from a pre-reformer and without a primary reformer therebetween. Jensen discloses a syngas process of natural gas and an oxygen fed autothermal reformer with a pre-reformer without a primary reformer therebetween. <i>E.g.</i>, Jensen 3:13-30 (ATR feed mixed with oxygen and steam to produce syngas of CO, CO₂, and H₂), 3:66-4:10 (pre-reformer upstream of an ATR). Jensen discloses production of ammonia synthesis gas designed to be cost efficient, have high reliability, improve energy efficiency, and reduce capital case. Jensen 1:6-22, 2:43-47. The synthesis gas contains CO, CO₂, and hydrogen. The POSA would know of the use of ATRs produce syngas for ammonia synthesis and would have known to combine QAFCO with Jensen with the expectation of success and to achieve the design improvements in an ammonia synthesis process.

Claims	Exemplary Citations
	Nielsen 2007 The combination of QAFCO with Nielsen 2007 renders obvious the conversion section including an autothermal reformer downstream from a pre-reformer and without a primary reformer therebetween. Nielsen 2007 discloses a syngas process of natural gas and an oxygen fed autothermal reformer with a pre-reformer without a primary reformer therebetween. <i>E.g.</i>, Nielsen 2007 [TOPSOE_0030113]. Nielsen 2007 discloses an ammonia synthesis process designed to reduce energy consumption, increase plant capacity, reduce carbon dioxide, and reduce equipment sizes to save on capital. Nielsen 2007 [TOPSOE_0030113 at 13, 15, 19-22]. The synthesis gas contains CO, CO₂, and hydrogen. The Nielsen 2007 presentation shows a process configuration with oxygen and steam, with desulphurized natural gas, fed into an ATR with a pre-reformer without a primary reformer therebetween to produce syngas.

Claims	Exemplary Citations
	 [TOPSOE_0030113 at 21]. The POSA would know of the use of ATRs produce syngas for ammonia synthesis and would have known to combine QAFCO with Nielsen 2007 with the expectation of success and to achieve the design improvements in an ammonia synthesis process. Lindell The combination of QAFCO with Lindell renders obvious the conversion section including an autothermal reformer downstream from a pre-reformer and without a primary reformer therebetween. Lindell discloses a syngas process of natural gas and an oxygen fed autothermal reformer with a pre-reformer without a primary reformer therebetween. <i>E.g.</i>, Lindell 2:17-22, 3:3-12, 3:42-44, 4:2-12, 4:14-29, 5:11-21, 5:49-5:66. The synthesis gas contains CO, CO₂, and hydrogen.

Claims	Exemplary Citations
	Lindell 3:12-15. Despite Lindell disclosing its process for use in GTL plants, the use of ATRs produce syngas for ammonia synthesis would have been well known to the POSA and the POSA would expect success combining Lindell with the ammonia synthesis process of QAFCO. <i>See, e.g.</i>, Syngas Production [TOPSOE_0028153 at 215-16, 221-223]. Indeed, Lindell recognizes that similar processes for CO₂ removal would be used on the syngas for ammonia synthesis that are not necessary for GTL processes. Lindell 1:52-61, 7:33-37. Gauthier The combination of QAFCO with Gauthier renders obvious the conversion section including an autothermal reformer downstream from a pre-reformer and without a primary reformer therebetween. Gauthier discloses an ammonia syngas production process using natural gas and an oxygen fed autothermal reformer with a pre-reformer without a primary reformer therebetween. <i>E.g.</i>, Gauthier ¶¶ 1-3, 11, 75, 85. The synthesis gas contains CO, CO₂, and hydrogen. The POSA would know of the use of ATRs produce syngas for ammonia synthesis and would have known to combine QAFCO with Gauthier with the expectation of success and to achieve the design improvements in an ammonia synthesis process. Price The combination of QAFCO with Price renders obvious the conversion section including an autothermal reformer downstream from a pre-reformer and without a primary reformer therebetween. Price discloses a syngas ammonia process of natural gas and an oxygen fed autothermal reformer without a primary reformer therebetween. <i>E.g.</i>, Price ¶¶ 7, 14, 39, 59-65. The POSA would know that depending on the makeup of the natural gas feed to the process, a pre-reformer

Claims	Exemplary Citations
	may be desirable before the ATR. Price teaches an ammonia process that reduces CO₂ emissions. Price Abstract, ¶ 21. The synthesis gas contains CO, CO₂, and hydrogen. The POSA would know of the use of ATRs produce syngas for ammonia synthesis and would have known to combine QAFCO with Price with the expectation of success and to achieve the design improvements in an ammonia synthesis process. Christensen The combination of QAFCO with Christensen renders obvious the conversion section including an autothermal reformer downstream from a pre-reformer and without a primary reformer therebetween. Christensen discloses a syngas process of natural gas and an oxygen fed autothermal reformer with a pre-reformer without a primary reformer therebetween. <i>E.g.</i>, Christensen 1:13-22 (at least 80% vol. O₂ into an autothermal reformer with a pre-reformer to produce syngas), 29-33 (well known to use ATR fed with natural gas to produce syngas). The synthesis gas contains CO, CO₂, and hydrogen. Despite Christensen disclosing its process for use in GTL plants, the use of ATRs produce syngas for ammonia synthesis would have been well known to the POSA and the POSA would expect success combining Christensen with the ammonia synthesis process of QAFCO. <i>See, e.g.</i>, Syngas Production [TOPSOE_0028153 at 215-16, 221-223].
1b treatment of said synthesis gas including at least a shift reaction of the carbon monoxide into CO₂, and subsequent separation of CO₂ from the gas, thus obtaining a CO₂-depleted synthesis gas	The QAFCO ammonia synthesis plant treats the syngas with a shift reaction of CO into CO₂ with the CO₂ subsequently separated from the syngas to create a CO₂ rich gas flow and a CO₂-depleted syngas stream.

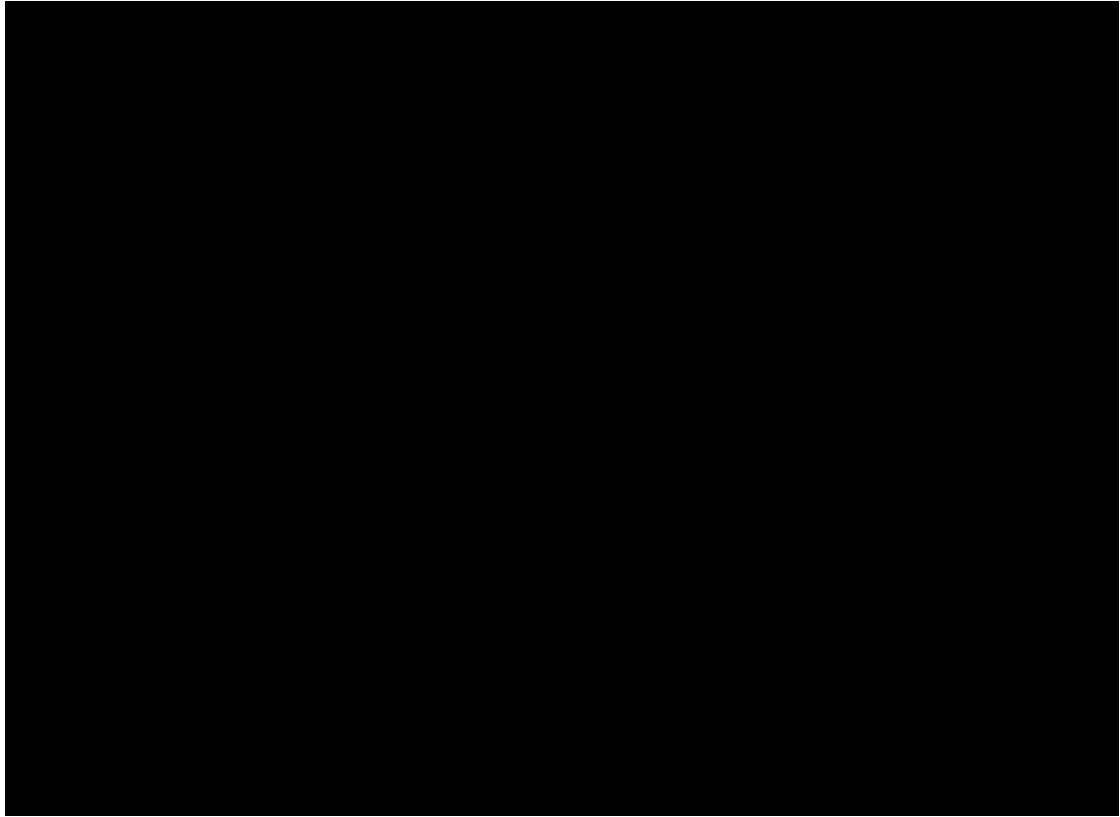
Claims	Exemplary Citations
and a CO₂-rich gaseous flow containing the CO₂ separated from the gas;	TOPSOE_0029862.

Claims	Exemplary Citations
	TOPSOE_0029863. TOPSOE_0029863.

Claims	Exemplary Citations
	TOPSOE_0029863.
1c separation of a part of said CO₂-depleted synthesis gas as fuel fraction, wherein said fuel fraction is fed as fuel to at least one furnace and wherein said separation of the fuel fraction includes the split of said CO₂-depleted synthesis gas into at least a first stream and a second stream, said first and second streams having the same composition, wherein the first stream forms the fuel fraction and the second stream is process gas intended for the synthesis of ammonia.	The QAFCO ammonia synthesis plant CO₂-depleted syngas stream [2250] is separated into a first and second stream with the first stream is used as a fuel fraction that is fed as fuel to at least one furnace and the second stream is process gas intended for the synthesis of ammonia with the first and second stream having the same composition. 

Claims	Exemplary Citations
	TOPSOE_0029864. TOPSOE_0029864.

Claims	Exemplary Citations
	TOPSOE_0029861. TOPSOE_0029865. The POSA would also know that when the primary reformer and secondary reformer and replaced with a pre-reformer and ATR without a primary reformer (see limitation 1a, above), that the syngas used as fuel would be used to preheat the natural gas feed to the pre-reformer and/or ATR or to generate and/or superheat steam to support the ammonia synthesis process. The POSA would also recognize, be motivated to, and would expect success in using the syngas as fuel to reduce the carbon emissions from the process.

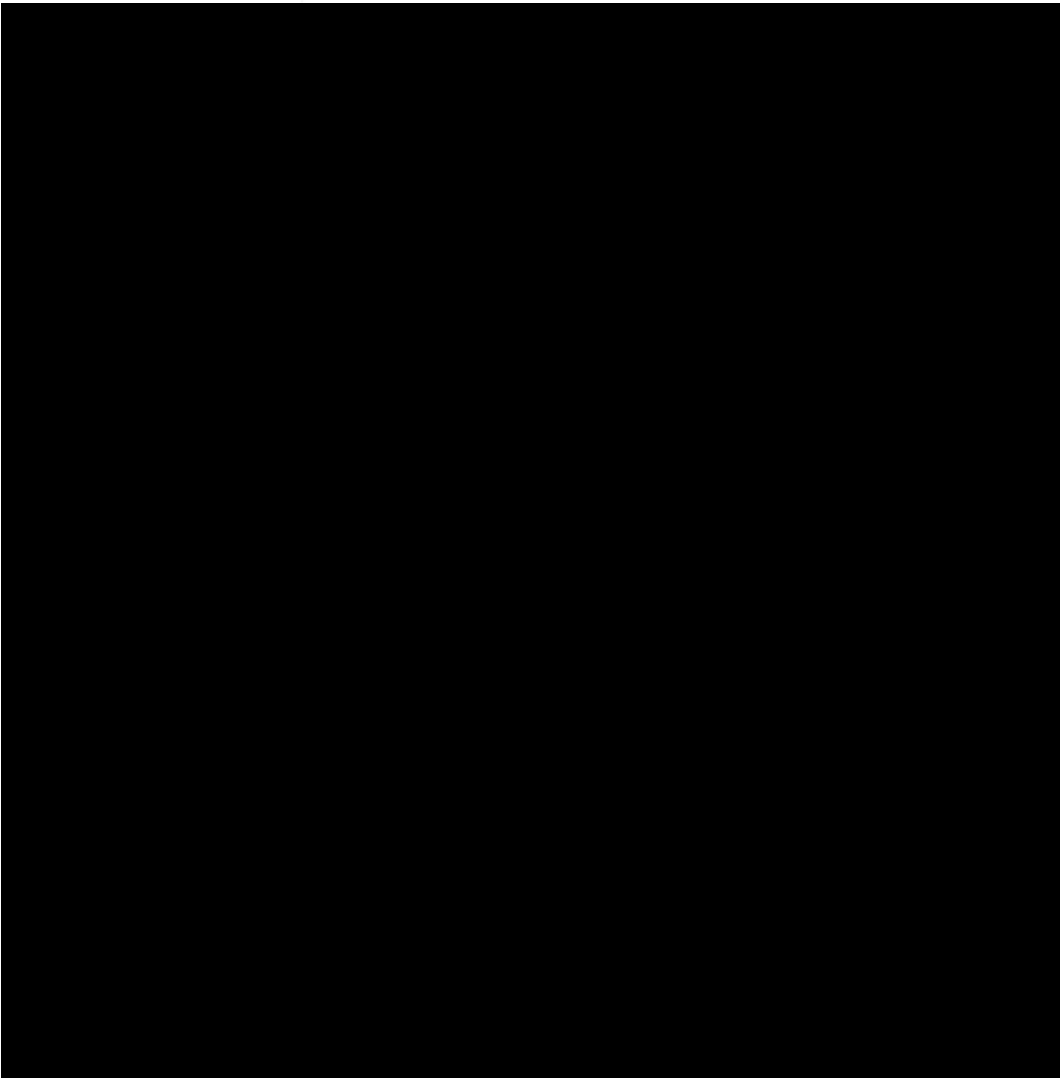
Claims	Exemplary Citations
5 The process of claim 1, further comprising a step for methanation of the synthesis gas and/or addition of nitrogen to the synthesis gas.	The QAFCO ammonia synthesis plant includes a step for methanation of the syngas [2250] from the CO₂ Absorber [C-302] in a methanator [R-301] in the process flow of the syngas.  TOPSOE_0029864 [from V-302 [sic]].
8 The process of claim 1, wherein said	It would have been obvious to a POSA, as of 2017 once replacing the desulphurized natural gas and air fed primary reformer and secondary reformer

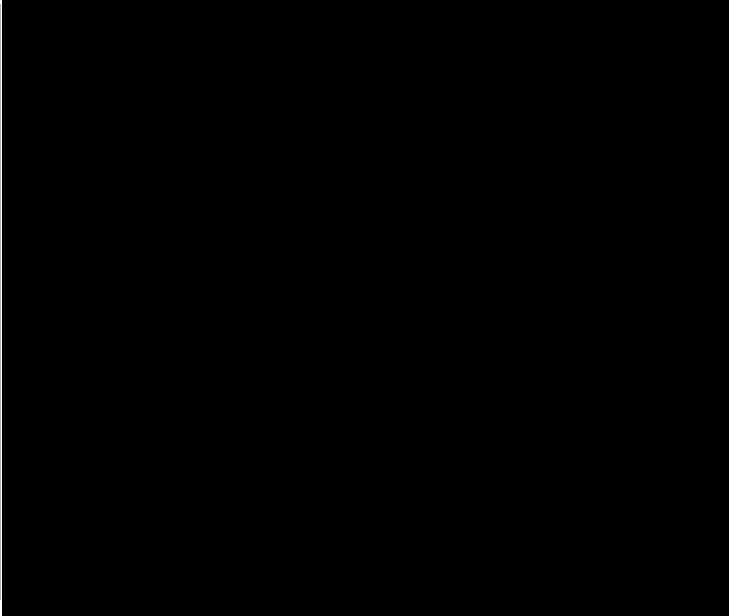
Claims	Exemplary Citations
enriched air contains at least 50% oxygen.	with an enriched air or oxygen fed autothermal reformer with a pre-reformer without a primary reformer therebetween, to use enriched air at least 50% oxygen. The POSA would understand that ATRs are well-known to be fed with oxygen-enriched air or oxygen to optimize performance of the ATR and the reactions taking place therein. The POSA would understand that a stream of oxygen is a stream of enriched air with at least 50% oxygen. The use of enriched air of at least 50% oxygen is a part of the normal design choices the POSA make in designing and operating the ammonia synthesis process. Thus, the POSA would have been motivated to modify QAFCO or to combine it with one or more of the references discussed below. Jensen Jensen Figure 2 shows “oxygen” being fed into the ATR. Jensen discloses that the feed for the ATR “is mixed with oxygen and additional steam.” Jensen 2:12-25. Jensen discloses using air being fed into an air separation unit (ASU) to convert the air into oxygen for use in the ATR. Jensen 5:24-28. Nielsen 2007 The Nielsen 2007 discloses an oxygen feed into the ATR. Nielsen 2007 [TOPSOE_0030113 at 21]. Lindell Lindell discloses feeding the ATR with “enriched air or oxygen.” Lindell 4:20-29; <i>see id.</i> at 2:19-22, 2:50-61, 3:65-4:11, 4:49-59, 5:8-21. Gauthier

Claims	Exemplary Citations
	Gauthier discloses the use of an autothermal reformer. Gauthier ¶¶ 11, 43, 75. The POSA would understand that ATRs are well-known to be fed with oxygen-enriched air or oxygen to optimize performance of the ATR and the reactions taking place therein. Price Price discloses air being fed into an air separation unit to then feed oxygen into an autothermal reformer. Price ¶¶ 4, 38-39. Christensen Christensen teaches that feeding an ATR with oxygen of at least 80% vol. and most preferably at least 95% vol. Christensen 1:10-19, 2:7-18.
9 The process of claim 1, wherein said enriched air contains at least 90% oxygen.	It would have been obvious to a POSA, as of 2017 once replacing the desulphurized natural gas and air fed primary reformer and secondary reformer with an enriched air or oxygen fed autothermal reformer with a pre-reformer without a primary reformer therebetween, to use enriched air at least 90% oxygen. The POSA would understand that ATRs are well-known to be fed with oxygen-enriched air or oxygen to optimize performance of the ATR and the reactions taking place therein. The POSA would understand that a stream of oxygen is a stream of enriched air with at least 90% oxygen. The use of enriched air of at least 90% oxygen is a part of the normal design choices the POSA make in designing and operating the syngas/ammonia synthesis process. Thus, the POSA would have been motivated to modify QAFCO or combine it with one or more of the references discussed below.

Claims	Exemplary Citations
	Jensen Jensen Figure 2 shows “oxygen” being fed into the ATR. Jensen discloses that the feed for the ATR “is mixed with oxygen and additional steam.” Jensen 2:12-25. Jensen discloses using air being fed into an air separation unit (ASU) to convert the air into oxygen for use in the ATR. Jensen 5:24-28. Nielsen 2007 Nielsen 2007 includes a figure that shows “oxygen” being fed into an ATR. Nielsen 2007 [TOPSOE_0030113 at 21]. Lindell Lindell discloses feeding the ATR with “enriched air or oxygen.” Lindell 4:20-29; <i>see id.</i> at 2:19-22, 2:50-61, 3:65-4:11, 4:49-59, 5:8-21. Gauthier Gauthier discloses the use of an autothermal reformer. Gauthier ¶¶ 11, 43, 75. The POSA would understand that ATRs are well-known to be fed with oxygen-enriched air or oxygen to optimize performance of the ATR and the reactions taking place therein. Price Price discloses air being fed into an air separation unit to then feed oxygen into an autothermal reformer. Price ¶¶ 4, 38-39. Christensen

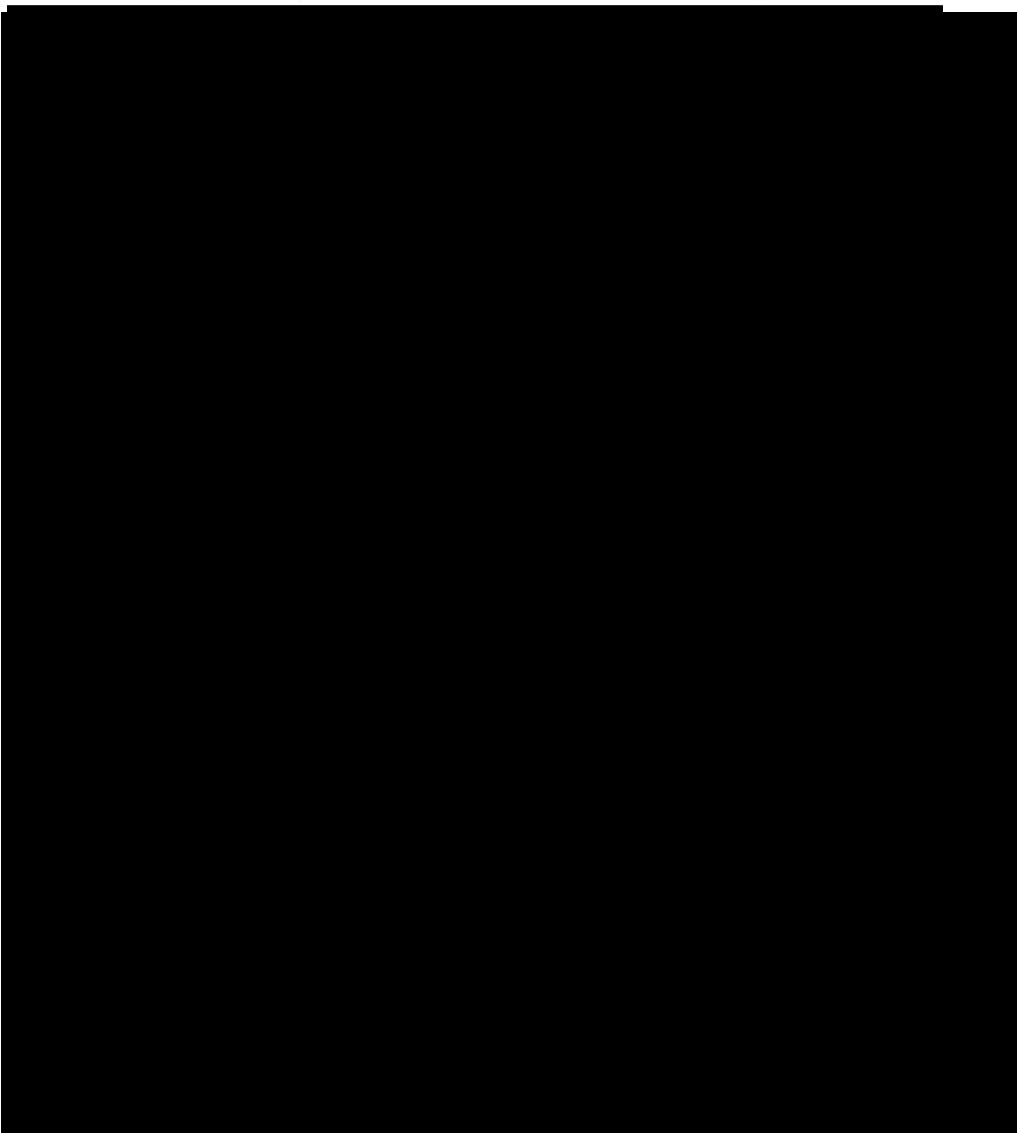
Claims	Exemplary Citations
	Christensen teaches that feeding an ATR with oxygen of at least 80% vol. and most preferably at least 95% vol. Christensen 1:10-19, 2:7-18.
10 The process of claim 1, wherein said fuel fraction of the synthesis gas feeds one or more of the following apparatuses: a steam production and/or superheating furnace; or one or more furnaces for pre-heating the charge of the autothermal reformer or natural-gas desulphurization section.	The QAFCO ammonia synthesis plant CO₂-depleted syngas stream is separated into a first and second stream with the first stream is used as a fuel fraction that is fed as fuel to one or more of a steam production and/or superheating furnace; or one or more furnaces for pre-heating the charge of the autothermal reformer or natural-gas desulphurization section.

Claims	Exemplary Citations
	 TOPSOE_0029861.

Claims	Exemplary Citations
	The POSA would also know that when the primary reformer and secondary reformer and replaced with a pre-reformer and ATR without a primary reformer (see limitation 1a, above), that the syngas used as fuel would be used to preheat the natural gas feed to the pre-reformer and/or ATR or to generate and/or superheat steam to support the ammonia synthesis process. The POSA would also recognize and be motivated to and expect success using the syngas as fuel to reduce the carbon emissions from the process.
18 The process of claim 1, wherein the fuel fraction is produced in excess with respect to the fuel necessary for the conversion section, the quantity of said fuel fraction exceeding that required being exported from the process; and regulation of the conversion section is performed by modulating the quantity of said fuel fraction directed towards the conversion section and the quantity exported from the process.	The QAFCO ammonia synthesis plant PFDs show a CO₂-depleted syngas stream used as a fuel [2325] in the conversion section.  TOPSOE_0029864.

Ex. A-02

Claims	Exemplary Citations
	TOPSOE_0029864.

Claims	Exemplary Citations
	

Claims	Exemplary Citations
	TOPSOE_0029861. The POSA would know that flow rate of surplus syngas produced and recycled to the conversion section or exported from the process is a design decision and selecting operating window such that excess syngas is produced would be obvious.
19 The process of claim 1, wherein: conversion of the charge of desulphurized natural gas and steam into the synthesis gas in the autothermal reformer is performed with a steam/carbon ratio not greater than 2.	It would have been obvious to a POSA, as of 2017, to operate the ATR with a steam/carbon ratio not greater than 2. The POSA would know that ATRs typically operate at a lower S/C ratio than traditional ammonia synthesis using primary reformers (e.g., steam methane reformers (SMRs)). The POSA would have been motivated to modify QAFCO or to combine it with one or more of the references discussed below. Jensen Jensen teaches that S/C ratios using an ATR can be as low as 0.3 and that lower S/C ratios with an ATR allows smaller equipment, capital savings, and higher syngas throughput. Jensen 2:5-10, 2:30-43, 3:8-11, 6:62-67. Jensen expressly discloses “The steam/carbon ratio in the reforming section may be 2.6-0.1, 2.4-0.1, 2-0.2, 1.5-0.3, 1.4-0.4, such as 1.2, 1.0 or 0.6.” Jensen 3:41-43. Nielsen 2007 The POSA would know that the operating range for the S/C is a design decision and selecting operating window based on design goals, including equipment sizing and carbon emissions. It would be obvious to select a S/C ratio less than two while using a pre-reformer and ATR as part of an ammonia synthesis process.

Claims	Exemplary Citations
	Lindell Lindell discloses operating the ATR and that operating they are “preferably operated at low S/C ratios.” Lindell 2:4-15, 3:3-12, 4:57-63, 6:44-54, <i>see id.</i> 6:40-48. Lindell also teaches that feed of natural gas and steam can be adjusted to “obtain the desired steam-to-carbon (S/C) ratio.” Lindell 2:37-50. The POSA would know that the operating range for the S/C is a design decision and selecting operating window based on design goals, including equipment sizing and carbon emissions. It would be obvious to select a S/C ratio less than two while using a pre-reformer and ATR as part of an ammonia synthesis process. Gauthier Gauthier discloses the use of an autothermal reformer and the reduction of the S/C ratio. Gauthier ¶ 10. The POSA would know that the operating range for the S/C is a design decision and selecting operating window based on design goals, including equipment sizing and carbon emissions. It would be obvious to select a S/C ratio less than two while using a pre-reformer and ATR as part of an ammonia synthesis process. Price Price discloses the use of an autothermal reformer operating “with a steam/reformable carbon ratio of 0.6.” Price ¶¶ 43, 59. The POSA would know that the operating range for the S/C is a design decision and selecting operating window based on design goals, including equipment sizing and carbon emissions. It would be obvious to select a S/C ratio less than two while using a pre-reformer and ATR as part of an ammonia synthesis process.

Claims	Exemplary Citations
	Christensen Christensen discloses the use of an autothermal reformer. Christensen 1:10-19, 2:7-18. The POSA would know that the operating range for the S/C is a design decision and selecting operating window based on design goals, including equipment sizing and carbon emissions. It would be obvious to select a S/C ratio less than two while using a pre-reformer and ATR as part of an ammonia synthesis process.

Exhibit A-03**Invalidity Chart for U.S. Patent No. 11,286,168 (the “168 Patent”) Based on the Tata Babrala Ammonia Plant in Uttar Pradesh, India as the primary reference**

Tata Chemicals Ltd. (“TCL”) licensed Topsoe ammonia synthesis technology to build and operate an ammonia synthesis plant in Uttar Pradesh, India by TCL Babrala, which appears to now be operated by Yara International. The Tata Babrala plant has been operating since around 1994. [TOPSOE_0030005; TOPSOE_0030024]. Topsoe was later retained for an expansion project to the Tata Babrala plant, which completed around 2011. [TOPSOE_0029982]. The Tata Babrala ammonia synthesis plant is therefore prior art to the ’168 patent at least because it reflects a process that was known and used by others and was “on sale” under post-AIA 35 U.S.C. § 102(a).

Secondary references included herein are prior art under post-AIA 35 U.S.C. § 102(a) as listed in the chart below.

No.	Number and Name	Type of Art	Prior Art Dates
1.	10,941,038 Jensen	Patent	Mar. 9, 2021
2.	9,683,176 Christensen	Patent	Jun. 20, 2017
3.	US2009/0298957 Gauthier	Patent App.	Dec. 3, 2009
4.	US2002/0143219 Price	Patent App.	Oct. 3, 2002
5.	“Future Energy Efficiency and CO ₂ Reduction Potential,” presented by Svend Erik Nielsen (Topsoe A/S) at 2007 IFA International Conference (“Nielsen 2007”).	Publication	Apr. 2007
6.	U.S. Pat. No. 9,353,022 to Lindell, et al. (“Lindell”).	Patent	Dec. 2, 2013

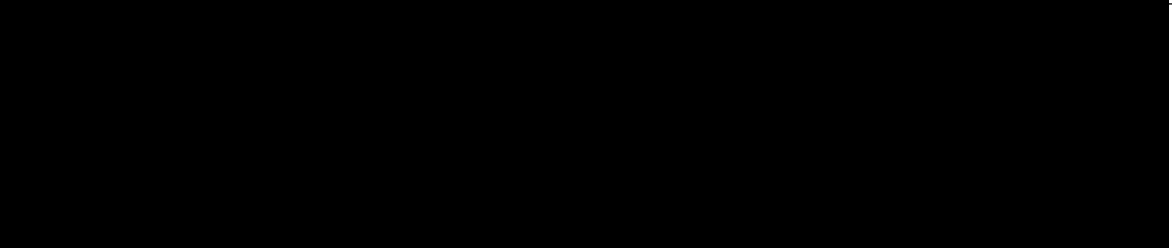
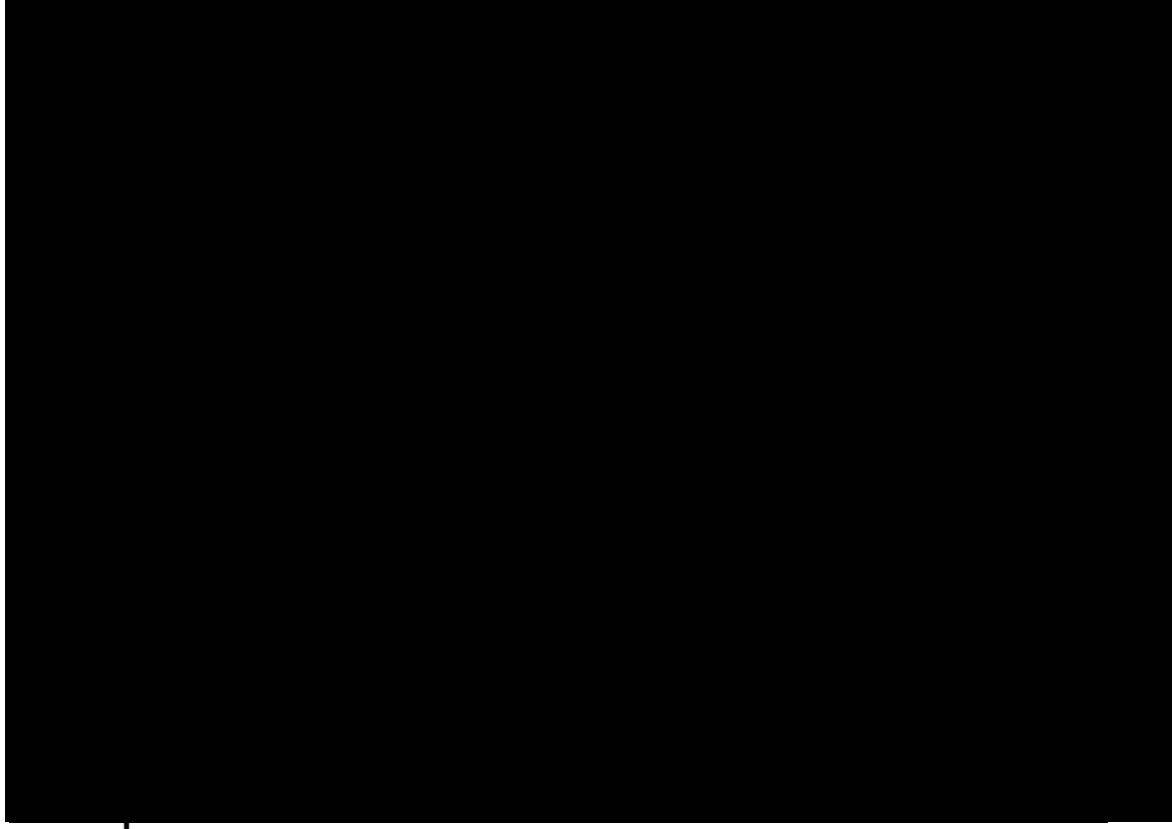
General Motivation to Combine Tata Babrala with one or more of Jensen, Christensen, Gauthier, Price, Lindell, and/or Nielsen 2007:

A POSA in the technical field of syngas production would have had a reasonable expectation of success in modifying the Tata Babrala ammonia synthesis plant to incorporate the pre-reformer-ATR process design disclosed in one or more of Jensen, Christensen, Gauthier, Price, Lindell, and/or Nielsen 2007. Such modifications would have been obvious because of the similar technologies involved, well-known and commonly used processes disclosed, commercial and financial motivations provided by such combinations, and/or a desire to reduce carbon emissions. For example, a POSA would readily understand

that Tata Babrala's use of a CO₂-depleted syngas stream to [REDACTED] would be equally applicable (and with a high expectation of success) to at least partially fuel the pre-heating of the pre-reformer of Jensen, Christensen, Gauthier, Price, Lindell, and/or Nielsen 2007 or for steam generation and/or superheating. Such modifications would have been selected from a finite number of identified means for generating syngas for downstream applications, including for example, ammonia synthesis. A POSA's motivations to make such modifications would also be part of routine optimization, design choices, addressing known problems in the art, responding to market pressures, and applying known principles and techniques.

Claims	Exemplary Citations
1p A process for synthesis of ammonia from natural gas, the process comprising:	The Tata Babrala ammonia synthesis plant performs a process for synthesis of ammonia from natural gas. [REDACTED] TOPSOE_0029994.

Claims	Exemplary Citations
	TOPSOE_0029994.
1a conversion of a charge of desulphurized natural gas and steam, with oxygen-enriched air or with oxygen, into a synthesis gas containing hydrogen, CO and CO₂, in a conversion section including an autothermal reformer downstream from a pre-reformer and without a primary reformer therebetween;	The Tata Babrala ammonia synthesis plant includes or it would have been obvious to a POSA to include a process step of converting a charge of desulphurized natural gas and steam with oxygen-enriched air or with oxygen, into a synthesis gas containing hydrogen, CO and CO₂, in a conversion section include an autothermal reformer downstream from a pre-reformer and without a primary reformer therebetween.

Claims	Exemplary Citations
	
	TOPSOE_0029994. 

Claims	Exemplary Citations
	TOPSOE_0029994. TOPSOE_0029994.

Claims	Exemplary Citations
	TOPSOE_0029994. TOPSOE_0029994. It would have been obvious to a POSA as of 2017 to replace the desulphurized natural gas and air fed primary reformer and secondary reformer with an enriched air or oxygen fed autothermal reformer with a pre-reformer without a primary reformer therebetween. The POSA would have been motivated to make such a substitution because ammonia processes with autothermal reformers with a pre-reformer without a primary reformer therebetween was a well-known process configuration. Such a configuration offers the benefit of reducing CO₂ emissions and reduced capital costs from reducing the size of the equipment required at least because of their lower S/C ration operation window, which would be goals of the

Claims	Exemplary Citations
	POSA. ATRs are also well known to be fed with oxygen-enriched air or oxygen to optimize performance of the ATR and the reactions taking place therein. The POSA would have had a reasonable expectation of success in modifying the Tata Babrala process to use an ATR and pre-reformer without a primary reformer therebetween also because such a configuration was well-known and had been shown to be successful in synthesis of ammonia while reducing carbon emissions. A POSA would know that before 2017, ATRs had become “the preferred route to synthesis gas” for processes such as ammonia synthesis. Syngas Production [TOPSOE_0028153 at 215-218]. Thus, the POSA would have been motivated to modify Tata Babrala itself or in combination with one or more of the references discussed below. Additionally, a POSA would readily understand that Tata Babrala’s use of a CO₂-depleted syngas stream to [REDACTED] [REDACTED] would be equally applicable (and with a high expectation of success) to at least partially fuel the pre-heating of the pre-reformer of Jensen, Christensen, Gauthier, Price, Lindell, and/or Nielsen 2007 or for steam generation and/or superheating. Jensen The combination of Tata Babrala with Jensen renders obvious the conversion section including an autothermal reformer downstream from a pre-reformer and without a primary reformer therebetween. Jensen discloses a syngas process of natural gas and an oxygen fed autothermal reformer with a pre-reformer without a primary reformer therebetween. <i>E.g.</i>, Jensen 3:13-30 (ATR feed mixed with oxygen and steam to produce syngas of CO, CO₂, and H₂), 3:66-4:10 (pre-reformer upstream of an ATR). Jensen discloses production of ammonia synthesis gas designed to be cost efficient, have high reliability, improve energy efficiency, and reduce capital case. Jensen 1:6-22, 2:43-47. The synthesis gas contains CO, CO₂, and hydrogen. The POSA would know of the use of ATRs produce syngas for ammonia synthesis and would have

Claims	Exemplary Citations
	known to combine Tata Babrala with Jensen with the expectation of success and to achieve the design improvements in an ammonia synthesis process. Nielsen 2007 The combination of Tata Babrala with Nielsen 2007 renders obvious the conversion section including an autothermal reformer downstream from a pre-reformer and without a primary reformer therebetween. Nielsen 2007 discloses a syngas process of natural gas and an oxygen fed autothermal reformer with a pre-reformer without a primary reformer therebetween. <i>E.g.</i>, Nielsen 2007 [TOPSOE_0030113]. Nielsen 2007 discloses an ammonia synthesis process designed to reduce energy consumption, increase plant capacity, reduce carbon dioxide, and reduce equipment sizes to save on capital. [TOPSOE_0030113 at 13, 15, 19-22]. The synthesis gas contains CO, CO₂, and hydrogen. The Nielsen 2007 presentation shows a process configuration with oxygen and steam, with desulphurized natural gas, fed into an ATR with a pre-reformer without a primary reformer therebetween to produce syngas.

Claims	Exemplary Citations
	[TOPSOE_0030113 at 21]. The POSA would know of the use of ATRs produce syngas for ammonia synthesis and would have known to combine Tata Babrala with Nielsen 2007 with the expectation of success and to achieve the design improvements in an ammonia synthesis process. Lindell The combination of Tata Babrala with Lindell renders obvious the conversion section including an autothermal reformer downstream from a pre-reformer and without a primary reformer therebetween. Lindell discloses a syngas process of natural gas and an oxygen fed autothermal reformer with a pre-reformer without a primary reformer therebetween. <i>E.g.</i>, Lindell 2:17-22, 3:3-12, 3:42-44, 4:2-12, 4:14-29, 5:11-21, 5:49-5:66. The synthesis gas contains CO, CO₂, and hydrogen. Lindell

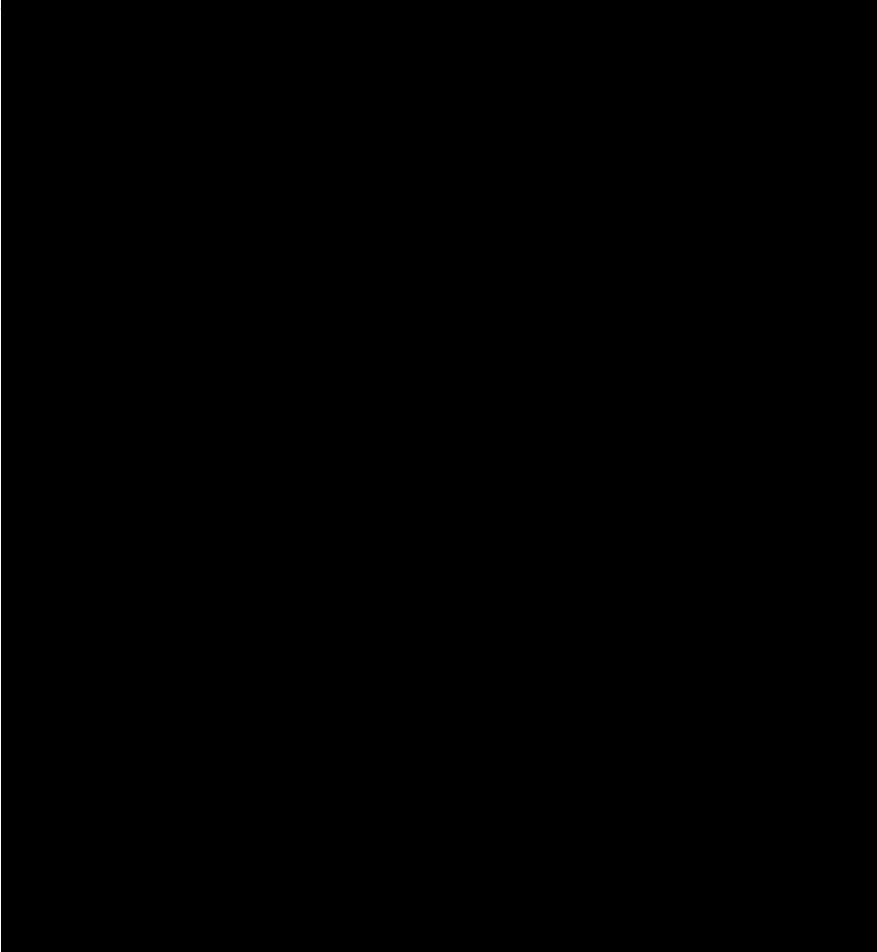
Claims	Exemplary Citations
	3:12-15. Despite Lindell disclosing its process for use in GTL plants, the use of ATRs produce syngas for ammonia synthesis would have been well known to the POSA and the POSA would expect success combining Lindell with the ammonia synthesis process of Tata Babrala. <i>See, e.g.</i>, Syngas Production [TOPSOE_0028153 at 215-16, 221-223]. Indeed, Lindell recognizes that similar processes for CO₂ removal would be used on the syngas for ammonia synthesis that are not necessary for GTL processes. Lindell 1:52-61, 7:33-37. Gauthier The combination of Tata Babrala with Gauthier renders obvious the conversion section including an autothermal reformer downstream from a pre-reformer and without a primary reformer therebetween. Gauthier discloses an ammonia syngas production process using natural gas and an oxygen fed autothermal reformer with a pre-reformer without a primary reformer therebetween. <i>E.g.</i>, Gauthier ¶¶ 1-3, 11, 75, 85. The synthesis gas contains CO, CO₂, and hydrogen. The POSA would know of the use of ATRs produce syngas for ammonia synthesis and would have known to combine Tata Babrala with Gauthier with the expectation of success and to achieve the design improvements in an ammonia synthesis process. Price The combination of Tata Babrala with Price renders obvious the conversion section including an autothermal reformer downstream from a pre-reformer and without a primary reformer therebetween. Price discloses a syngas ammonia process of natural gas and an oxygen fed autothermal reformer without a primary reformer therebetween. <i>E.g.</i>, Price ¶¶ 7, 14, 39, 59-65. The POSA would know that depending on the makeup of the natural gas feed to the process, a pre-reformer may be desirable before the ATR. Price teaches an ammonia process that reduces CO₂ emissions.

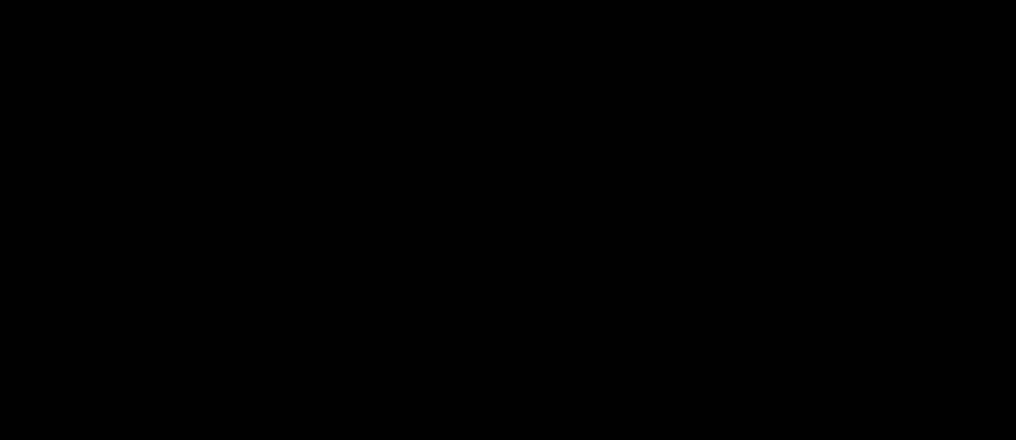
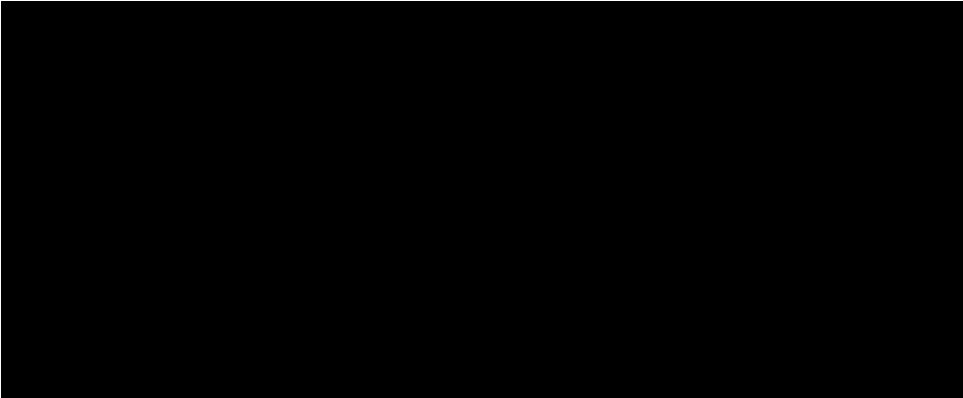
Claims	Exemplary Citations
	Price Abstract, ¶ 21. The synthesis gas contains CO, CO₂, and hydrogen. The POSA would know of the use of ATRs produce syngas for ammonia synthesis and would have known to combine Tata Babrala with Price with the expectation of success and to achieve the design improvements in an ammonia synthesis process. Christensen The combination of Tata Babrala with Christensen renders obvious the conversion section including an autothermal reformer downstream from a pre-reformer and without a primary reformer therebetween. Christensen discloses a syngas process of natural gas and an oxygen fed autothermal reformer with a pre-reformer without a primary reformer therebetween. <i>E.g.</i>, Christensen 1:13-22 (at least 80% vol. O₂ into an autothermal reformer with a pre-reformer to produce syngas), 29-33 (well known to use ATR fed with natural gas to produce syngas). The synthesis gas contains CO, CO₂, and hydrogen. Despite Christensen disclosing its process for use in GTL plants, the use of ATRs produce syngas for ammonia synthesis would have been well known to the POSA and the POSA would expect success combining Christensen with the ammonia synthesis process of Tata Babrala. <i>See, e.g.</i>, Syngas Production [TOPSOE_0028153 at 215-16, 221-223].
1b treatment of said synthesis gas including at least a shift reaction of the carbon monoxide into CO₂, and subsequent separation of CO₂ from the gas, thus obtaining a CO₂-depleted synthesis gas and a CO₂-rich gaseous flow containing the CO₂ separated from the gas;	The Tata Babrala ammonia synthesis plant treats the syngas with a shift reaction of CO into CO₂ with the CO₂ subsequently separated from the syngas to create a CO₂ rich gas flow and a CO₂-depleted syngas stream.

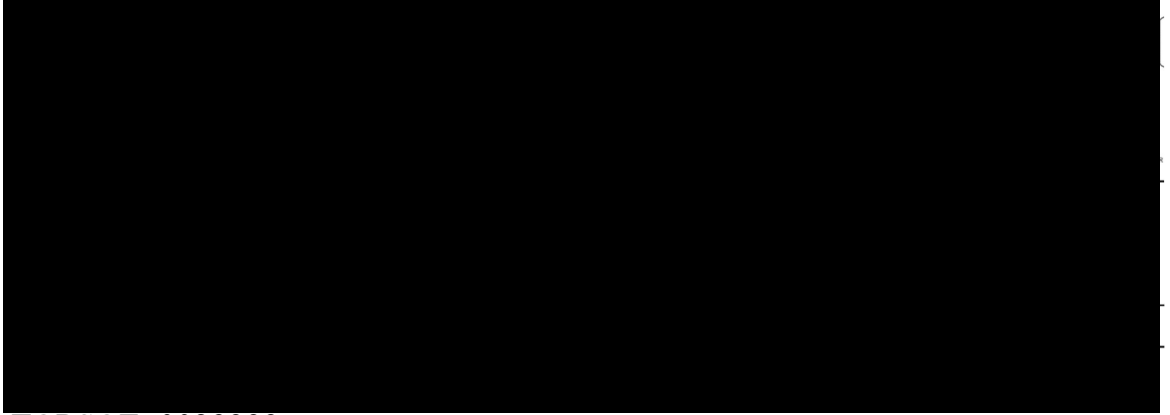
Claims	Exemplary Citations
	TOPSOE_0029996.

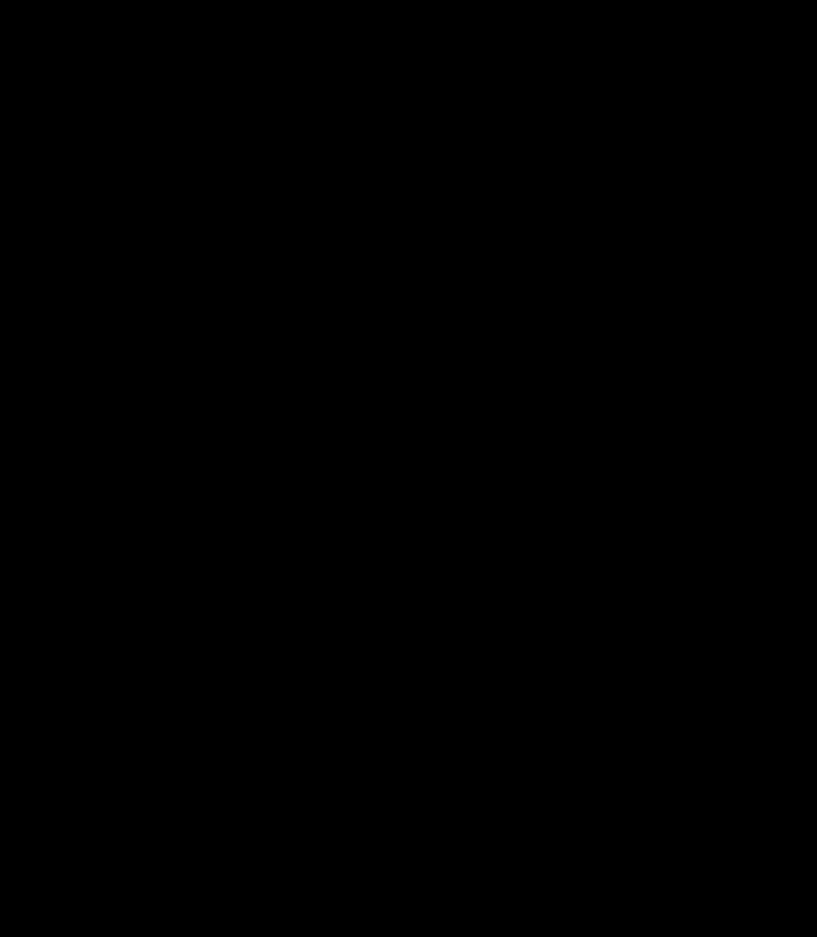
Claims	Exemplary Citations
	TOPSOE_0029997. TOPSOE_0029997.

Claims	Exemplary Citations
1c separation of a part of said CO₂-depleted synthesis gas as fuel fraction, wherein said fuel fraction is fed as fuel to at least one furnace and wherein said separation of the fuel fraction includes the split of said CO₂-depleted synthesis gas into at least a first stream and a second stream, said first and second streams having the same composition, wherein the first stream forms the fuel fraction and the second stream is process gas intended for the synthesis of ammonia.	The Tata Babrala ammonia synthesis plant CO₂-depleted syngas stream [2282] is separated into a first and second stream with the first stream is used as a fuel fraction that is fed as fuel to at least one furnace and the second stream is process gas intended for the synthesis of ammonia with the first and second stream having the same composition.

Claims	Exemplary Citations
	 TOPSOE_0029998.

Claims	Exemplary Citations
	
	TOPSOE_0029998.
	
	TOPSOE_0029994. 

Claims	Exemplary Citations
	 TOPSOE_0029999. The POSA would also know that when the primary reformer and secondary reformer and replaced with a pre-reformer and ATR without a primary reformer (see limitation 1a, above), that the syngas used as fuel would be used to preheat the natural gas feed to the pre-reformer and/or ATR or to generate and/or superheat steam to support the ammonia synthesis process. The POSA would also recognize, be motivated to, and would expect success in using the syngas as fuel to reduce the carbon emissions from the process.
5 The process of claim 1, further comprising a step for methanation of the synthesis gas and/or addition of nitrogen to the synthesis gas.	The Tata Babrala ammonia synthesis plant includes a step for methanation of the syngas [2250] in a methanator [R-2311] in the process flow of the syngas.

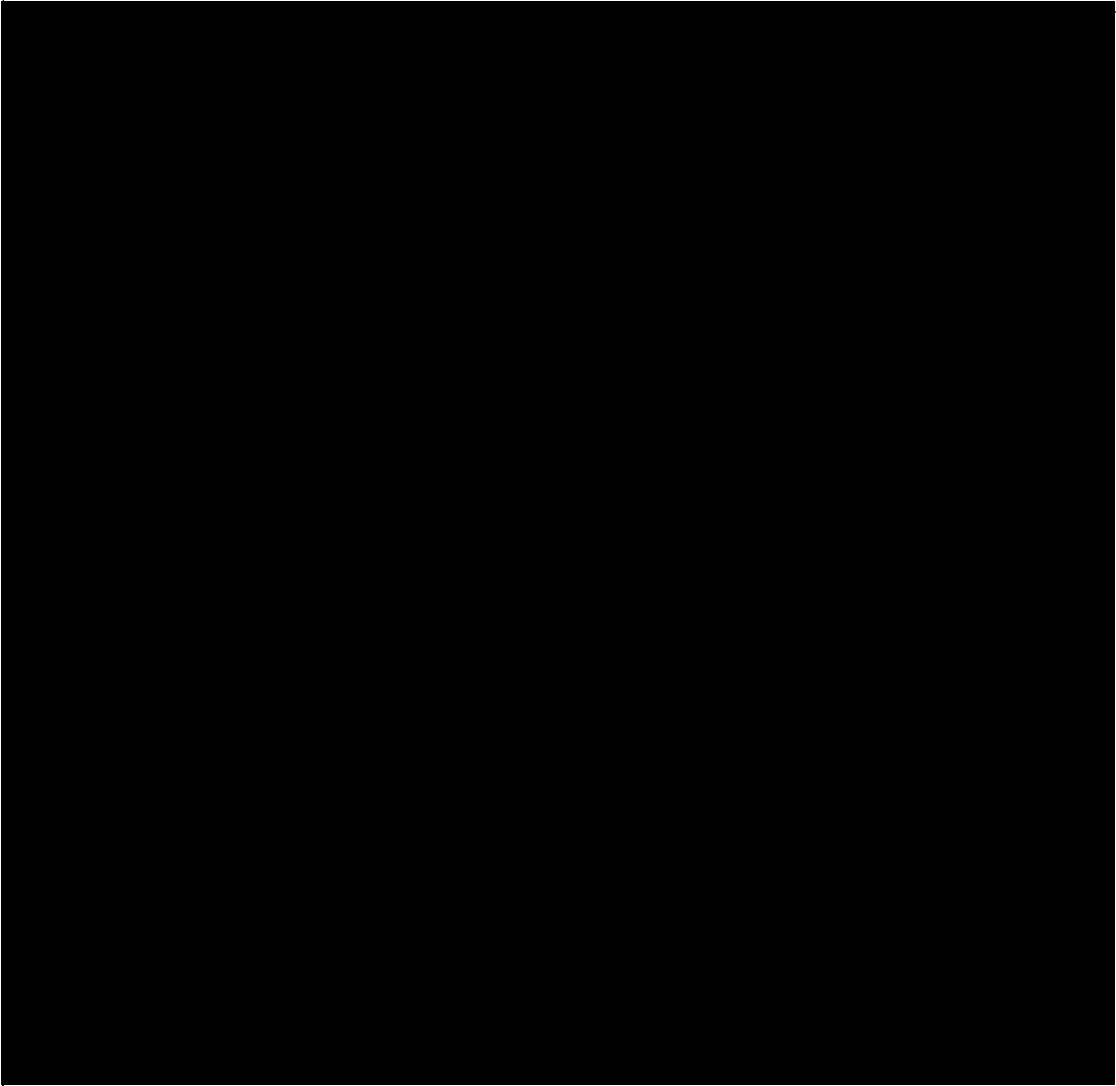
Claims	Exemplary Citations
	 TOPSOE_0029998.
8 The process of claim 1, wherein said	It would have been obvious to a POSA, as of 2017 once replacing the desulphurized natural gas and air fed primary reformer and secondary reformer with an enriched air or oxygen fed autothermal reformer with a pre-reformer without a primary

Claims	Exemplary Citations
enriched air contains at least 50% oxygen.	reformer therebetween, to use enriched air at least 50% oxygen. The POSA would understand that ATRs are well-known to be fed with oxygen-enriched air or oxygen to optimize performance of the ATR and the reactions taking place therein. The POSA would understand that a stream of oxygen is a stream of enriched air with at least 50% oxygen. The use of enriched air of at least 50% oxygen is a part of the normal design choices the POSA make in designing and operating the ammonia synthesis process. Thus, the POSA would have been motivated to modify Tata Babrala or to combine it with one or more of the references discussed below. Jensen Jensen Figure 2 shows “oxygen” being fed into the ATR. Jensen discloses that the feed for the ATR “is mixed with oxygen and additional steam.” Jensen 2:12-25. Jensen discloses using air being fed into an air separation unit (ASU) to convert the air into oxygen for use in the ATR. Jensen 5:24-28. Nielsen 2007 The Nielsen 2007 discloses an oxygen feed into the ATR. Nielsen 2007 [TOPSOE_0030113 at 21]. Lindell Lindell discloses feeding the ATR with “enriched air or oxygen.” Lindell 4:20-29; <i>see id.</i> at 2:19-22, 2:50-61, 3:65-4:11, 4:49-59, 5:8-21. Gauthier Gauthier discloses the use of an autothermal reformer. Gauthier ¶¶ 11, 43, 75. The POSA would understand that ATRs are well-known to be fed with oxygen-enriched

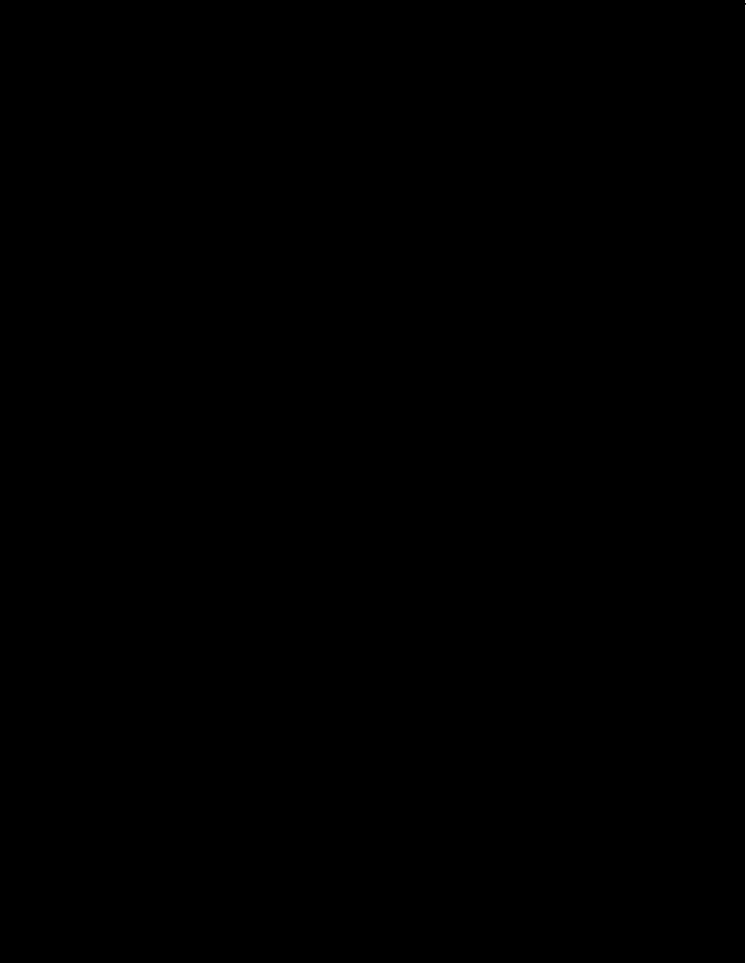
Claims	Exemplary Citations
	air or oxygen to optimize performance of the ATR and the reactions taking place therein. Price Price discloses air being fed into an air separation unit to then feed oxygen into an autothermal reformer. Price ¶¶ 4, 38-39. Christensen Christensen teaches that feeding an ATR with oxygen of at least 80% vol. and most preferably at least 95% vol. Christensen 1:10-19, 2:7-18.
9 The process of claim 1, wherein said enriched air contains at least 90% oxygen.	It would have been obvious to a POSA, as of 2017 once replacing the desulphurized natural gas and air fed primary reformer and secondary reformer with an enriched air or oxygen fed autothermal reformer with a pre-reformer without a primary reformer therebetween, to use enriched air at least 90% oxygen. The POSA would understand that ATRs are well-known to be fed with oxygen-enriched air or oxygen to optimize performance of the ATR and the reactions taking place therein. The POSA would understand that a stream of oxygen is a stream of enriched air with at least 90% oxygen. The use of enriched air of at least 90% oxygen is a part of the normal design choices the POSA make in designing and operating the syngas/ammonia synthesis process. Thus, the POSA would have been motivated to modify Tata Babrala or combine it with one or more of the references discussed below. Jensen

Claims	Exemplary Citations
	Jensen Figure 2 shows “oxygen” being fed into the ATR. Jensen discloses that the feed for the ATR “is mixed with oxygen and additional steam.” Jensen 2:12-25. Jensen discloses using air being fed into an air separation unit (ASU) to convert the air into oxygen for use in the ATR. Jensen 5:24-28. Nielsen 2007 Nielsen 2007 includes a figure that shows “oxygen” being fed into an ATR. Nielsen 2007 [TOPSOE_0030113 at 21]. Lindell Lindell discloses feeding the ATR with “enriched air or oxygen.” Lindell 4:20-29; <i>see id.</i> at 2:19-22, 2:50-61, 3:65-4:11, 4:49-59, 5:8-21. Gauthier Gauthier discloses the use of an autothermal reformer. Gauthier ¶¶ 11, 43, 75. The POSA would understand that ATRs are well-known to be fed with oxygen-enriched air or oxygen to optimize performance of the ATR and the reactions taking place therein. Price Price discloses air being fed into an air separation unit to then feed oxygen into an autothermal reformer. Price ¶¶ 4, 38-39. Christensen Christensen teaches that feeding an ATR with oxygen of at least 80% vol. and most preferably at least 95% vol. Christensen 1:10-19, 2:7-18.

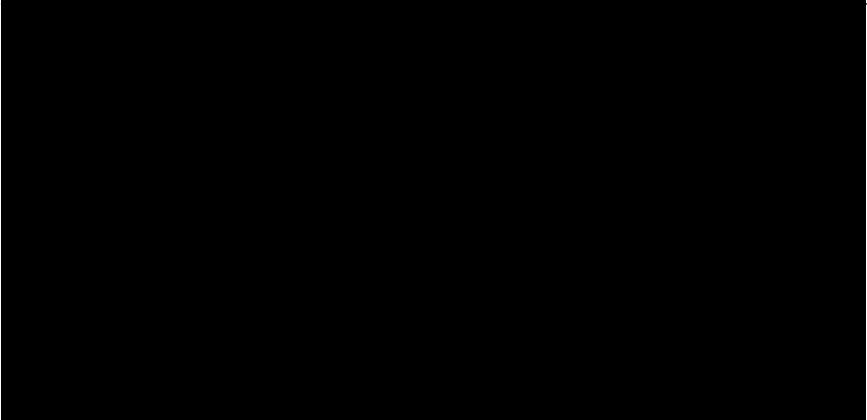
Claims	Exemplary Citations
10 The process of claim 1, wherein said fuel fraction of the synthesis gas feeds one or more of the following apparatuses: a steam production and/or superheating furnace; or one or more furnaces for pre-heating the charge of the autothermal reformer or natural-gas desulphurization section.	The Tata Babrala ammonia synthesis plant CO₂-depleted syngas stream is separated into a first and second stream with the first stream is used as a fuel fraction that is fed as fuel to one or more of a steam production and/or superheating furnace; or one or more furnaces for pre-heating the charge of the autothermal reformer or natural-gas desulphurization section. [REDACTED] [REDACTED] [REDACTED]

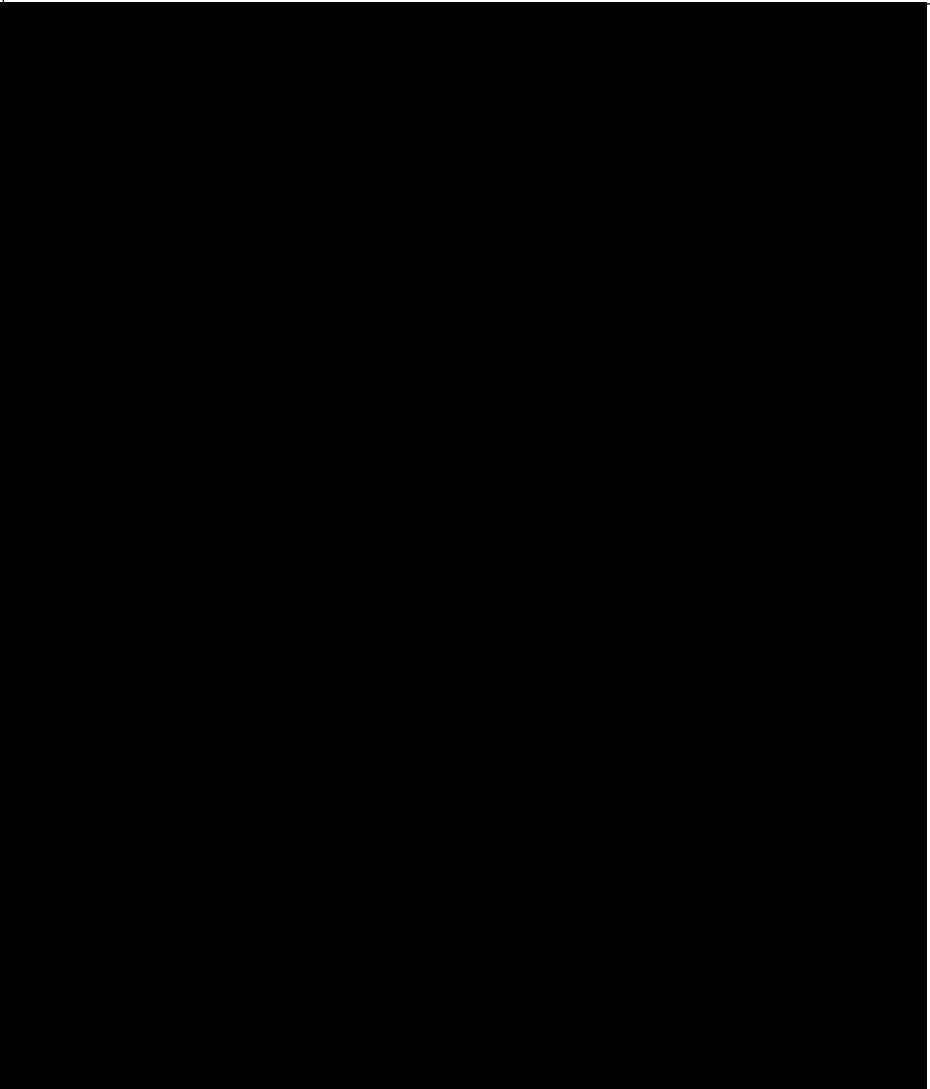
Claims	Exemplary Citations
	 TOPSOE_0029994.

Claims	Exemplary Citations
	The POSA would also know that when the primary reformer and secondary reformer and replaced with a pre-reformer and ATR without a primary reformer (see limitation 1a, above), that the syngas used as fuel would be used to preheat the natural gas feed to the pre-reformer and/or ATR or to generate and/or superheat steam to support the ammonia synthesis process. The POSA would also recognize and be motivated to and expect success using the syngas as fuel to reduce the carbon emissions from the process.
18 The process of claim 1, wherein the fuel fraction is produced in excess with respect to the fuel necessary for the conversion section, the quantity of said fuel fraction exceeding that required being exported from the process; and regulation of the conversion section is performed by modulating the quantity of said fuel fraction directed towards the conversion section and the quantity exported from the process.	The Tata Babrala ammonia synthesis plant PFDs show a CO₂-depleted syngas stream used as a fuel [2325] in the conversion section.

Claims	Exemplary Citations
	 TOPSOE_0029998.

Ex. A-03

Claims	Exemplary Citations
	 TOPSOE_0029998.

Claims	Exemplary Citations
	 TOPSOE_0029994.

Claims	Exemplary Citations
	The POSA would know that flow rate of surplus syngas produced and recycled to the conversion section or exported from the process is a design decision and selecting operating window such that excess syngas is produced would be obvious.
19 The process of claim 1, wherein: conversion of the charge of desulphurized natural gas and steam into the synthesis gas in the autothermal reformer is performed with a steam/carbon ratio not greater than 2.	It would have been obvious to a POSA, as of 2017, to operate the ATR with a steam/carbon ratio not greater than 2. The POSA would know that ATRs typically operate at a lower S/C ratio than traditional ammonia synthesis using primary reformers (e.g., steam methane reformers (SMRs)). The POSA would have been motivated to modify Tata Babrala or to combine it with one or more of the references discussed below. Jensen Jensen teaches that S/C ratios using an ATR can be as low as 0.3 and that lower S/C ratios with an ATR allows smaller equipment, capital savings, and higher syngas throughput. Jensen 2:5-10, 2:30-43, 3:8-11, 6:62-67. Jensen expressly discloses “The steam/carbon ratio in the reforming section may be 2.6-0.1, 2.4-0.1, 2-0.2, 1.5-0.3, 1.4-0.4, such as 1.2, 1.0 or 0.6.” Jensen 3:41-43. Nielsen 2007 The POSA would know that the operating range for the S/C is a design decision and selecting operating window based on design goals, including equipment sizing and carbon emissions. It would be obvious to select a S/C ratio less than two while using a pre-reformer and ATR as part of an ammonia synthesis process. Lindell Lindell discloses operating the ATR and that operating they are “preferably operated at low S/C ratios.” Lindell 2:4-15, 3:3-12, 4:57-63, 6:44-54, <i>see id.</i> 6:40-48. Lindell

Claims	Exemplary Citations
	also teaches that feed of natural gas and steam can be adjusted to “obtain the desired steam-to-carbon (S/C) ratio.” Lindell 2:37-50. The POSA would know that the operating range for the S/C is a design decision and selecting operating window based on design goals, including equipment sizing and carbon emissions. It would be obvious to select a S/C ratio less than two while using a pre-reformer and ATR as part of an ammonia synthesis process. Gauthier Gauthier discloses the use of an autothermal reformer and the reduction of the S/C ratio. Gauthier ¶ 10. The POSA would know that the operating range for the S/C is a design decision and selecting operating window based on design goals, including equipment sizing and carbon emissions. It would be obvious to select a S/C ratio less than two while using a pre-reformer and ATR as part of an ammonia synthesis process. Price Price discloses the use of an autothermal reformer operating “with a steam/reformable carbon ratio of 0.6.” Price ¶¶ 43, 59. The POSA would know that the operating range for the S/C is a design decision and selecting operating window based on design goals, including equipment sizing and carbon emissions. It would be obvious to select a S/C ratio less than two while using a pre-reformer and ATR as part of an ammonia synthesis process. Christensen Christensen discloses the use of an autothermal reformer. Christensen 1:10-19, 2:7-18. The POSA would know that the operating range for the S/C is a design decision

Claims	Exemplary Citations
	and selecting operating window based on design goals, including equipment sizing and carbon emissions. It would be obvious to select a S/C ratio less than two while using a pre-reformer and ATR as part of an ammonia synthesis process.