

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

TOPSOE, INC.,

Petitioner

v.

L'AIR LIQUIDE, SOCIÉTÉ ANONYME POUR L'ETUDE ET
L'EXPLOITATION DES PROCÉDÉS GEORGES CLAUDE,

Patent Owner

Case IPR2025-01174
Patent No 11,673,805

PATENT OWNER PRELIMINARY RESPONSE

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I. Introduction

Claim 1 recites alternative configurations (parallel or series) for endothermic and autothermal reforming steps. The Petition challenges only the parallel configuration. Claim 1 also recites (1) reforming a first part of a feed gas stream in the endothermic reforming step to produce a first synthesis gas stream, (2) reforming a second part of the feed gas stream in the autothermal reforming step to produce a second synthesis gas stream, and (3) combining the first synthesis gas stream and the second synthesis gas stream to produce a third synthesis gas stream.

Institution should be denied because the Petition's grounds are defective for each of several independent reasons.

First, the Petition fails to show that its asserted combination of the Martin and Rafati references would include combining a first synthesis gas stream output from an endothermic reforming step with a second synthesis gas stream output from an autothermal reforming step, as required by Claim Element 1.3. Nor could Petitioner have done so. Martin and Rafati's second synthesis gas stream from their autothermal reformer is further reformed in the endothermic reformer and thereby converted into a different synthesis gas.

Second, the Petition fails to identify *any* first synthesis gas stream from the endothermic reformer, as required by Claim Element 1.2.1, that can be combined with the second synthesis gas stream from the autothermal reformer. Petitioner

points to a combined product stream exiting Martin's and Rafati's endothermic reactor for the first synthesis gas stream. But Petitioner also points to that same stream as the *third* synthesis gas stream. It cannot be both, meaning Petitioner failed to identify the distinct first and third synthesis gas streams recited by claim 1.

Third, Claim Element 1.1.1 requires the feed gas stream to comprise steam, and Claim Element 1.3 requires reforming part of that feed gas stream in the autothermal reformer. But the Petition fails to allege that the feed gas stream to Martin's or Rafati's autothermal reformer includes steam. To the contrary, each of Martin and Rafati unambiguously show steam being added to only to a part of the feed gas stream that is provided only to their endothermic reactor.

Each of the foregoing defects is alone sufficient to undermine Petitioner's mapping of the sole independent claim, and is therefore fatal to all of the Petition's grounds. Petitioner therefore cannot shown any reasonable likelihood of success.

II. The Petition Maps Only the Parallel Configuration of Claim 1

The sole independent claim—Claim 1—recites two options for the configuration of the endothermic reforming step and the autothermal reforming step: (1) a series configuration and (2) a parallel configuration. *Compare* EX1001, FIG. 14:57-67 (parallel: mixing respective outputs of parallel endothermic reforming and autothermal reforming) *with id.*, 15:1-3 (series: routing first synthesis gas output of

endothermic reforming as a feed into an autothermal reforming step). Examples of these two alternative configurations are also shown in the figures of the '805 Patent.

Figure 2 (annotated below) shows an example of the parallel configuration. *See* EX1001, 9:28-31 (“parallel arrangement of the reforming units for the endothermic and autothermal reforming steps”). In the parallel configuration, “[a] feed gas stream FG is divided into two substreams,” a first of which “is introduced into an [blue] endothermic reforming unit 200” and the second of which is “introduced into an [red] autothermal reforming unit 201.” EX1001, 11:16-23.

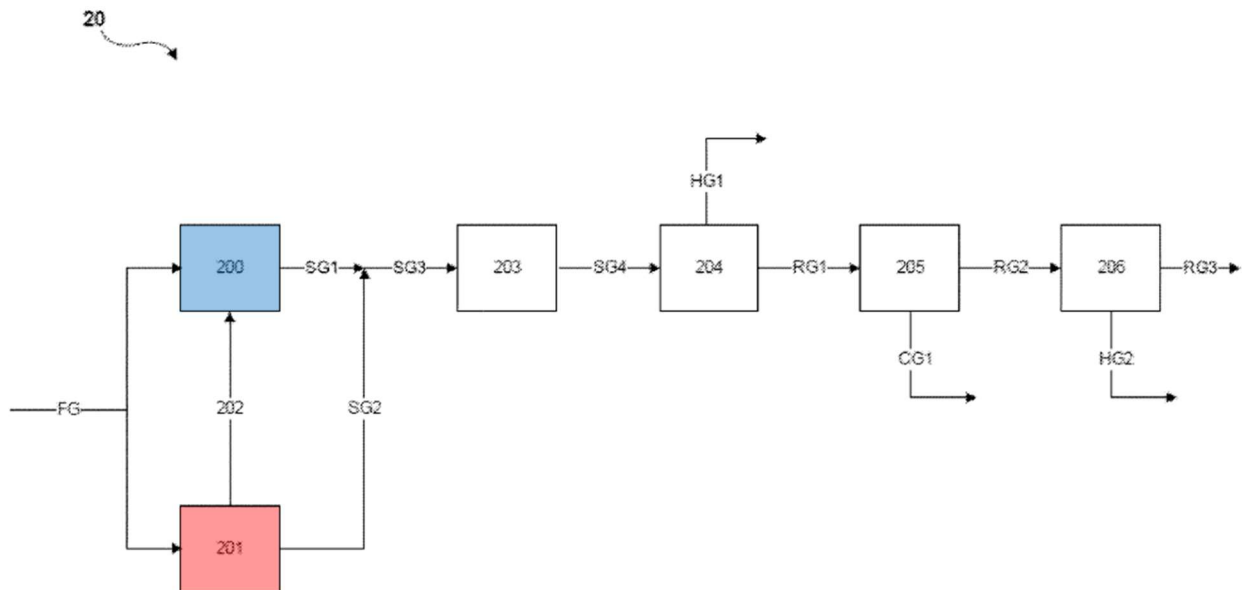


Fig. 2

Figure 3 (annotated below) shows an example of the series configuration. *See* EX1001, 9:32-35 (“series arrangement”). In the series configuration, “[a] feed gas stream FG is introduced into an [blue] endothermic reforming unit 200 and converted

into a synthesis gas stream SG1” that “is [next] converted not to a synthesis gas stream in the [red] autothermal reforming unit 201.” EX1001, 13:9-13.

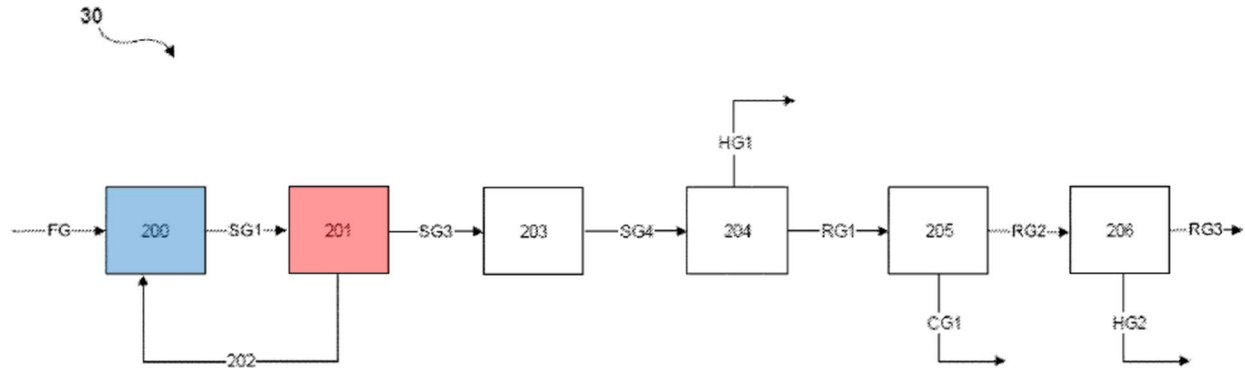


Fig. 3

Of these two configurations, the Petition in this proceeding addresses only the parallel configuration. *See, e.g.,* Pet., 11 (“Martin details the process steps and gas stream flows of the dual reformer arranged *in parallel* ...”), 33 (“Martin discloses ... combining the first synthesis gas stream and the second synthesis gas stream”); *see also* Paper 3, 4 (contrasting with the different “01173 ‘Series’ Petition”—“the ‘Parallel’ Petition (Petition 2, IPR2025-01174) demonstrates that it was known and/or obvious to employ a parallel configuration of reformers”).

Thus, the Petition maps only the parallel configuration of claim 1.

III. Claim Construction

The claims are interpreted according to the Phillips claim construction standard. 83 Fed. Reg. 51340, 51340-44 (Oct. 11, 2018); *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (*en banc*).

Patent Owner does not believe formal constructions are necessary to understand what is claimed. Nevertheless, the Petition glosses over key differences between the claims and the cited art, and the below summaries are therefore included to emphasize certain express features of the claims.

A. first synthesis gas stream

Element 1.2 recites “reforming at least a portion of the feed gas stream in an endothermic reforming step over a reforming catalyst thereby producing a first synthesis gas stream.” The plain language of this feature indicates that the first synthesis gas stream is the *synthesis gas* output of the endothermic reforming step. The specification reinforces this plain language: “In the endothermic reforming unit 200, the first substream of the feed gas stream FG is *converted* to a synthesis gas stream SG1.” EX1001, 11:23-25; *see also id.*, FIG. 2 (SG1 output from endothermic reforming unit 200).

B. second synthesis gas stream

Element 1.3 recites, for the parallel configuration mapped in this Petition, “reforming a portion of the feed gas stream in an autothermal reforming step thereby producing a second synthesis gas stream.” The plain language of this feature indicates that the second synthesis gas stream is the *synthesis gas* output of the autothermal reforming step. The specification reinforces this plain language: “In the autothermal reforming unit 201, the second substream of the feed gas stream FG

is *converted* to a synthesis gas stream SG2.” EX1001, 11:26-28; *see also id.*, FIG. 2 (SG2 output from autothermal reforming unit 201).

C. third synthesis gas stream

Element 1.3 also recites, for the parallel configuration mapped in this Petition, “combining the first synthesis gas stream and the second synthesis gas stream thereby producing a third synthesis gas stream.” The plain language of this feature means that the *synthesis gas* output of the endothermic reforming step is mixed with the *synthesis gas* output of the autothermal reforming step to form a combined synthesis gas stream. The specification reinforces this plain language: “The synthesis gas streams SG1 and SG2 that are produced by the endothermic reforming unit 200 and the autothermal reforming unit 201 are combined to give a mixed synthesis gas stream SG3” EX1001, 11:59-62; *see also id.*, FIG. 2 (SG2 output from autothermal reforming unit 201 combined with SG1 output from endothermic reforming unit 200).

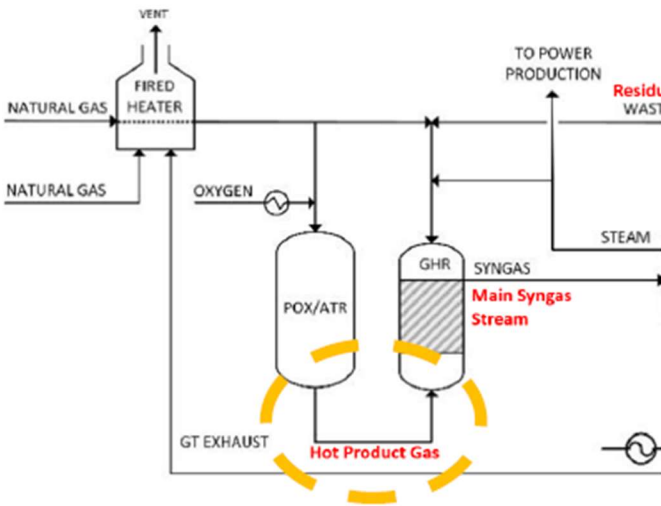
The specification also distinguishes this “combining” of the output synthesis gas streams SG1 and SG2 from the different approach of the series configuration. *Compare* EX1001, 11:14-23 *with id.*, 12:65-67, 13:9-13. Specifically, in the series configuration, the feed gas stream FG is routed to the endothermic reforming unit 200 to be converted into a first synthesis gas stream SG1. EX1001, 13:9-11. And, unlike the parallel configuration, the first synthesis gas stream SG1 is then routed to

the autothermal reforming unit 201 to convert that first synthesis gas stream SG1 into a third synthesis gas stream SG3. *See* EX1001, 12:65-67, 13:9-13, FIG. 3.

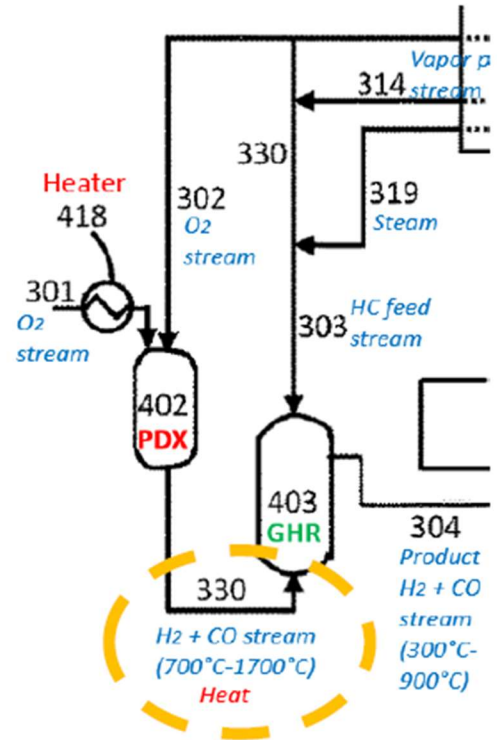
The plain language of the claims therefore requires that the output of the endothermic reformer step (first synthesis gas) is combined with the output of the autothermal reformer step (second synthesis gas) to form a third synthesis gas.

IV. Element 1.3: The Petition Fails to Show that Martin-Rafati Combines a First Synthesis Gas Stream from an Endothermic Reforming Step with a Second Synthesis Gas Stream from an Autothermal Reforming Step

The Petition alleges that Martin and Rafati each disclose Claim Element 1.3 in *the same way*. Pet., 33 (“Martin discloses...”), 34 (“Rafati similarly teaches...”). The Petition elsewhere reinforces that both are alleged to function in the same way. Pet., 23 (“For example, each of the individual reforming steps recited in Martin and Rafati could be combined with no change in their respective functions.”), 20 (“to the extent Martin lacks sufficient teaching, there are several reasons why a POSA would have been motivated to supplement the process of Martin with the *details* disclosed in Rafati”). The Petition illustrates their similarities with the following annotated excerpts of Martin’s FIG. 7 and Rafati’s FIG. 2:



EX1006
 MARTIN



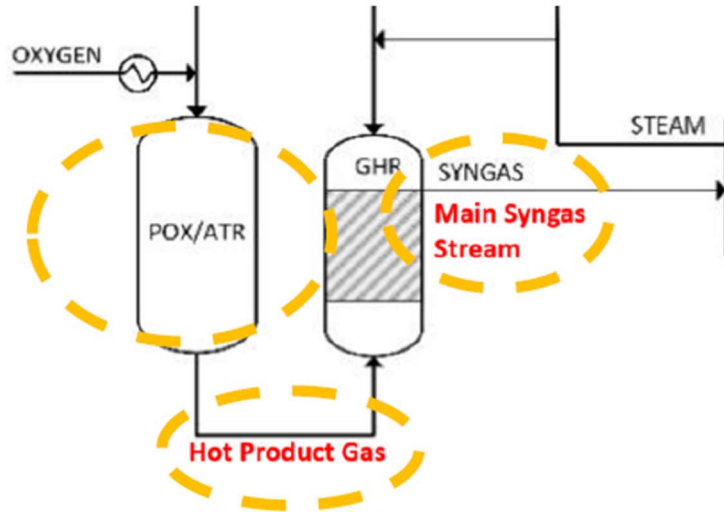
EX1015
 RAFATI

Pet., 23.

A. The Martin-Rafati combination

For Claim Element 1.3, the Petition first points to Martin’s Figure 7 and statement that “eventually both syngas streams combines to form the main syngas stream.” Pet., 33. But the context of that phrase—including Figure 7 to which it relates—makes clear that Martin does *not* combine a first synthesis gas stream output from an endothermic reformer with a second synthesis gas stream output from an autothermal reformer. Instead, as shown in Martin’s Figure 7 the output of the

autothermal reformer (POX/ATX) is sent to the endothermic reformer (GHR) for further reforming and conversion into a new synthesis gas stream:

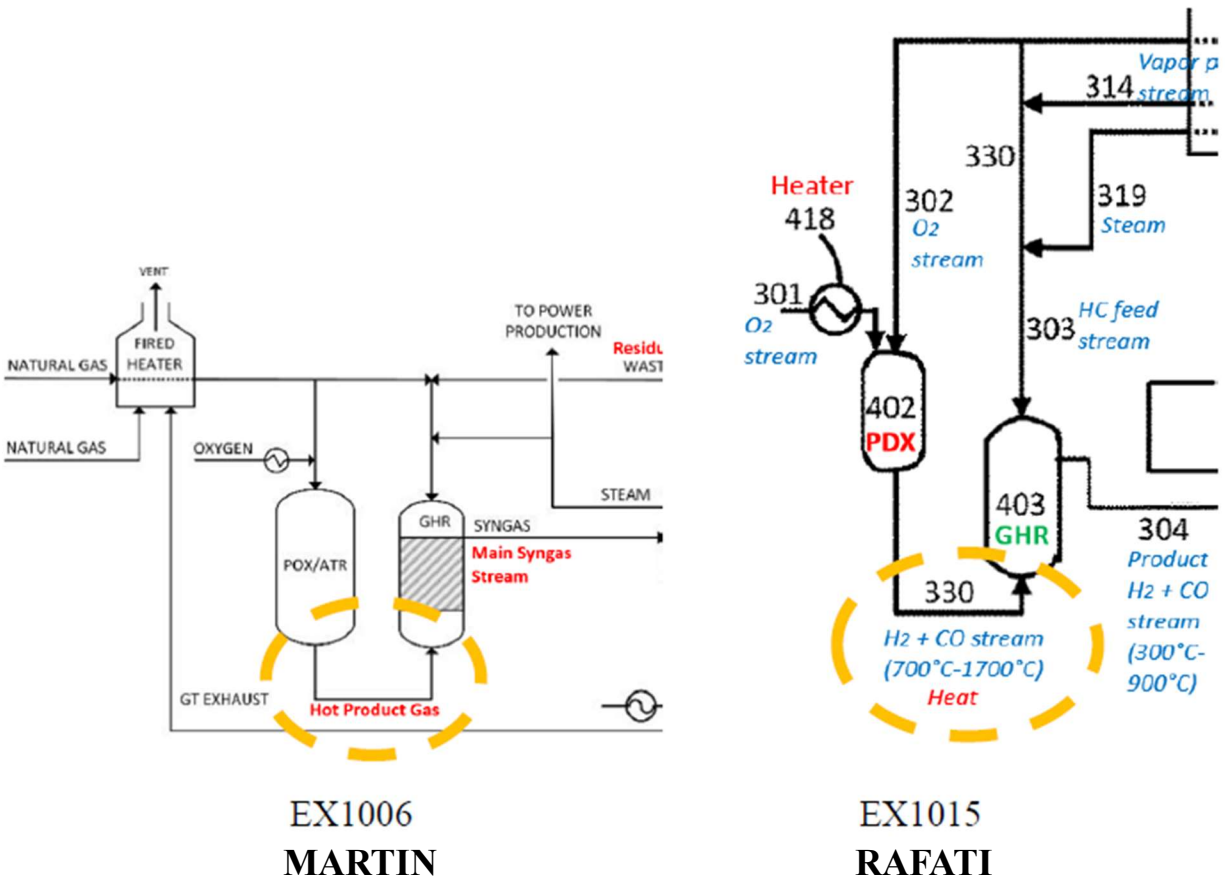


Pet., 33 (annotated excerpt of Martin FIG. 7).

Martin states that “[t]he hot product gas at 1050-1400 C (depending on the type of partial oxidation reactor used) drives the steam methane reforming reactions within the GHR tubes, and eventually both syngas streams combines to form the main syngas stream at 550-600 C.” EX1006, 12. But Martin is silent about what happens to the Hot Product Gas after entering the GHR or how Martin’s streams “combine” to form the main syngas stream.

However, Rafati—which Petitioner asserts to have functionally *identical* reforming steps—explains that the “product H_2+CO stream 330 enters the base of the GHR reactor 403, *undergoes endothermic reforming reactions*, and leaves the GHR as stream 304.” EX1015, ¶[0125]; *see also* Pet., 23 (“each of the individual

reforming steps recited in Martin and Rafati could be combined with no change in their respective functions”). Petitioner’s annotation of Rafati’s FIG. 2 (inset below) illustrates the similarities in their reforming process.



Pet., 23. Like Martin, Rafati explains that, first, “methane in stream 302 [is] combined in the PDX reactor [402] with an oxygen stream 301” to form a “product H₂+CO stream 330.” EX1015, ¶¶[0124]-[0125]. And, as in Martin, the “product H₂+CO stream 330 enters the base of the GHR reactor 403, *undergoes endothermic reforming reactions*, and leaves the GHR [403] as stream 304”—*not* as stream 330. EX1015, ¶[0125]. Thus, Rafati unambiguously explains that—in the process of

Martin and Rafati—the alleged second synthesis gas output from the autothermal reformer (Martin’s POX/ATR reactor or Rafati’s PDX reactor) is further reformed and thereby converted into a *different* synthesis gas stream. EX1015, ¶[0125] (“product H₂+CO stream 330” converted into “total product H₂+CO stream 304”); EX1006, 12 (“hot product gas” converted into “main syngas stream”).

B. The Petition fails to address that the alleged second synthesis gas stream is converted before it can be combined with any first synthesis gas stream

The Petition overlooks a critical flaw in its mapping of Martin-Rafati to Claim Element 1.3. In particular, and as explained immediately above, the “Hot Product Gas” (second synthesis gas) output from Martin’s POX/ATR (autothermal reforming step) is *not* combined with a synthesis gas output from Martin’s GHR (endothermic reforming step). To the contrary, Martin’s “Hot Product Gas” is further reformed in the GHR such that it is converted into a *different* synthesis gas stream and is *no longer* the first synthesis gas. Cf. EX1001, 13:11-13 (’805 Patent describing series configuration “The synthesis gas stream SG1 is *converted* to a synthesis gas stream SG3 in the autothermal reforming unit 201.”). Thus, even accepting that Martin’s syngas streams are “combined” to form its main syngas stream, that is *not* the same as a first synthesis gas stream output from an endothermic reformer being combined with a second synthesis gas stream output from an autothermal reformer.

The Petition fails to address that the alleged second synthesis gas stream from Martin's POX/ATR (or Rafati's PDX) is further reformed or converted into a new synthesis gas stream *before* it can be combined with any purported first synthesis gas stream output by the mapped endothermic reformer (Martin or Rafati's GHR).¹ This alone undermines Petitioner's mapping to Claim Element 1.3 and is therefore fatal to all of Petitioner's grounds.

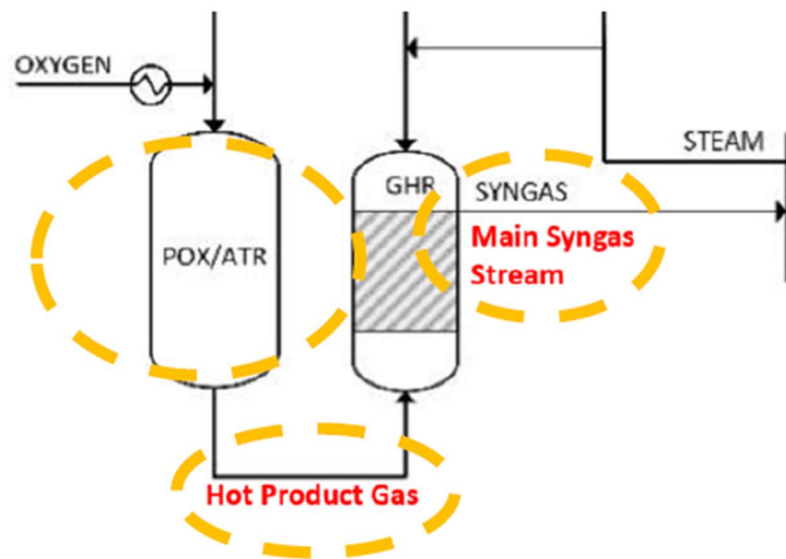
V. Element 1.2.1: The Petition Fails to Identify a First Synthesis Gas Stream that Can Be Combined with the alleged Second Synthesis Gas Stream

The Petition contends that "Martin discloses, at least inherently, a first synthesis gas stream comprising hydrogen, CO, CO₂, and unreacted methane." Paper 23 (citing EX1006, p.12; EX1003, ¶¶336, 338–339). As explained in Section III above, the plain language of the claims recites that the first synthesis gas stream output from the endothermic reforming step (Martin's or Rafati's GHR) exists in a form that can be combined with a second synthesis gas stream output from the autothermal reforming step. *See* Pet., viii (Claim Element 1.3: "combining the first synthesis gas stream and the second synthesis gas stream").

The Petition's mapping of Claim Element 1.2.1 is deficient. For the first synthesis gas of Element 1.2.1, the Petition points solely to the product stream exiting the GHR: "the GHR product stream of Rafati, which includes hydrogen,

¹ As explained below, the Petition also fails to identify a first synthesis gas stream.

CO, CO₂, and unreacted methane, is equivalent to that of the *first* synthesis gas stream of the '805 patent.” Pet., 32. But that product stream from the GHR is *also* identified for the *third* synthesis gas recited in Element 1.3. Pet., 33. Specifically, the Petition contends that “the main syngas stream [from the GHR] of Martin is equivalent to that of the third synthesis gas stream of the '805 patent.” *Id.*

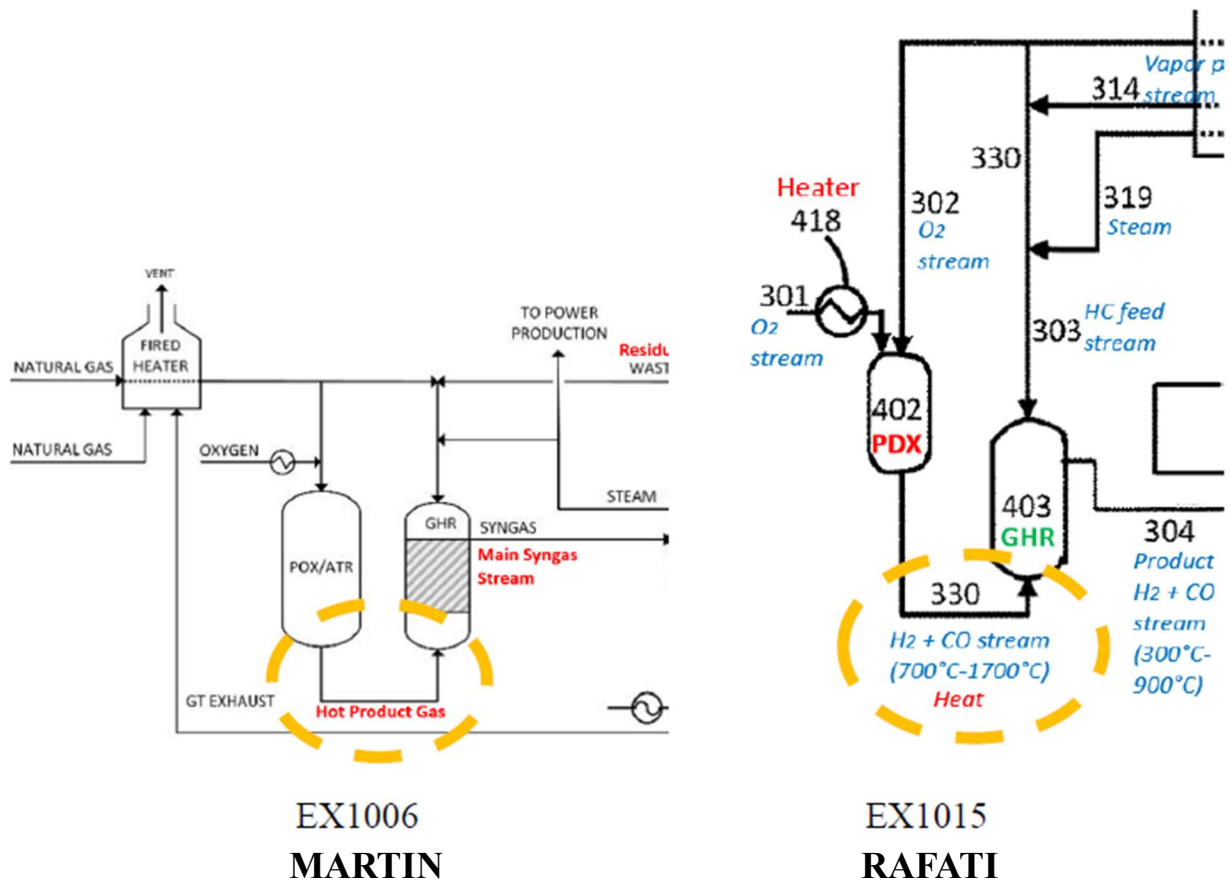


Pet., 33 (annotated excerpt of Martin’s FIG. 7). That product/main syngas stream from Martin’s or Rafati’s GHR *cannot be* both the *first* synthesis gas stream of Element 1.2.1 and the *third* synthesis gas stream of Element 1.3. This alone undermines Petitioner’s mapping to Claim Element 1.2.1 and is therefore fatal to all of Petitioner’s grounds.

VI. Elements 1.1.1 & 1.3: The Petition Fails to Show a Feed Gas Stream Comprising Steam Being Reformed In An Autothermal Reformer

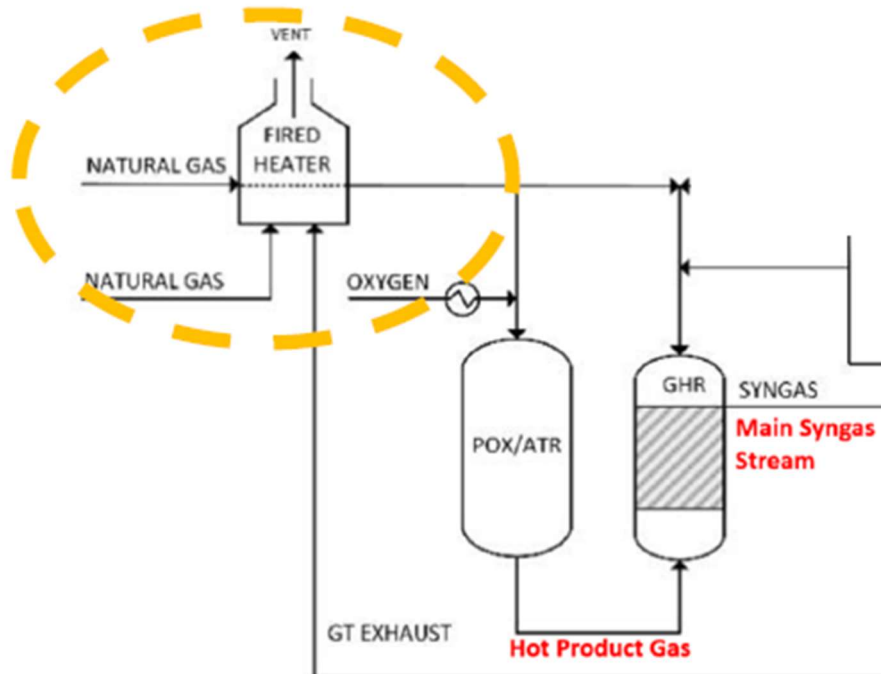
Element 1.1 recites “providing a feed gas stream,” and Element 1.1.1 recites that “the feed gas stream comprises a hydrocarbon component *and steam*.” Pet., viii. Element 1.3 recites “reforming a portion of *the feed gas stream* in an autothermal reforming step.” Thus, the plain language of claim 1 requires the feed gas stream reformed in the autothermal reforming step to comprise steam.

As explained above, the Petition maps Martin’s POX/ATR and Rafati’s PDX reactor 403 to Element 1.3’s autothermal reformer. *See, e.g.,* Pet., 33-34.



Pet., 23 (annotated excerpts of Martin’s FIG. 7 and Rafati’s FIG. 2).

For the feed gas stream of Element 1.1, the Petition points to the natural gas stream that is preheated in Martin’s fired heater, as shown below:



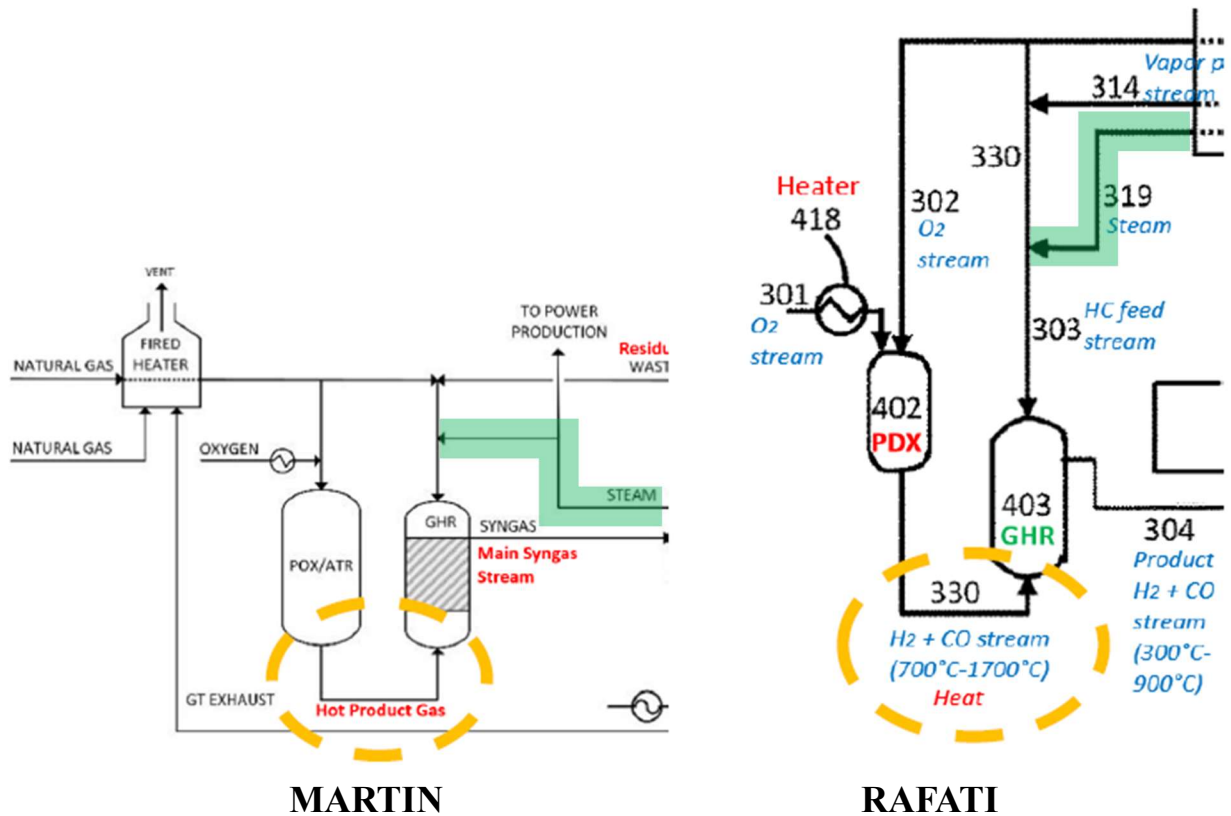
Pet., 28 (annotated excerpt of Martin’s FIG. 7).

However, for the steam of Element 1.1.1, the Petition points solely to the alleged endothermic reformer—the *GHR*. Pet., 28 (Martin expressly notes that “[t]he hot product gas...drives the steam methane reforming reactions *within the GHR tubes*.”); *see also id.* (“Moreover, a POSA would have understood that a steam methane reforming process in a *GHR reformer* necessarily requires that steam be present in the input stream.”).

The Petition’s mapping of Element 1.1.1 is deficient for each of two independent reasons.

First, the Petition fails to even allege—much less show—that the feed gas stream reformed in the alleged autothermal reformer (Martin’s POX/ATR or Rafati’s PDX) comprises steam. That alone undermines the Petition’s mapping to Elements 1.1.1 and 1.3, and is therefore fatal to all of the Petition’s grounds.

Second, Martin and Rafati plainly show [green] steam added *only* to natural gas that is fed to the alleged endothermic reactor (Martin’s or Rafati’s GHR)—*not* to natural gas fed to the autothermal reactor (Martin’s POX/ATR or Rafati’s PDX).



Pet., 23 (annotated excerpts of Martin’s FIG. 7 and Rafati’s FIG. 2); see also EX1015, ¶[0127] (“steam stream 319 passes through the heat exchanger 412 before combining with methane stream 303 for entry into the *GHR* 403.”)

Thus, even if the Petition had alleged that steam was added to the natural gas entering Martin's POX/ATR or Rafati's PDX, Martin and Rafati plainly indicate otherwise. These express disclosures also undermine the Petition's mapping to Elements 1.1.1 and 1.3, and is therefore also fatal to all of Petitioner's grounds.

VII. Conclusion

For the foregoing reasons, institution should be denied.

Dated: October 9, 2025

Respectfully submitted,

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Lead Counsel for Patent Owner

CERTIFICATE OF WORD COUNT

Pursuant to 37 C.F.R. § 42.24(b)(1), the undersigned certifies that this Paper exclusive of the table of contents, certificate of service, and this certificate of word count—includes 2,794 words. The undersigned relies upon the word count feature of Microsoft Word.

/Eagle H. Robinson/

Eagle H. Robinson (Reg. No. 61,361)

CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. § 42.6(e), the undersigned certifies that on October 9, 2025, a complete copy of the foregoing Patent Owner Preliminary Response was served on Petitioner via email (by consent), at the following email address(s):

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