

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

AIR PRODUCTS AND CHEMICALS, INC.,
Petitioner

v.

EVONIK OPERATIONS GMBH and EVONIK CORPORATION,
Patent Owner.

Case IPR2024-00611

Patent 10,471,380 B2

**EXPERT DECLARATION OF MARKUS UNGERANK IN SUPPORT OF
PATENT OWNER'S PRELIMINARY RESPONSE TO PETITION FOR
INTER PARTES REVIEW OF UNITED STATES PATENT NO. 10,471,380**

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I, Markus Ungerank, declare as follows:

The following is my written Declaration submitted in support of Patent Owner Evonik Operations GmbH and Evonik Corporation's ("**Patent Owner**" or "**Evonik**") Preliminary Response to the Petition for *Inter Partes* Review of U.S. Patent No. 10,471,380 B2 to Priske (the "**380 Patent**, Ex AP 1001) filed by Petitioner Air Products and Chemicals Inc.'s ("**Petitioner**" or "**AP**").

I. Summary of my Declaration and Opinions

1. I understand that Petitioner challenges claims 1–23 of the '380 Patent on two grounds:

Ground 1: Claims 1-5, 7, 9 and 11-23 are obvious in view of U.S. Patent No. 8,999,038 to Ungerank et al. (AP-1006; "**Ungerank**") and *Structural optimization of membrane-based biogas upgrading processes* authored by Scholz et al. (AP-1007; "**Scholz**"); and

Ground 2: Claims 1-13, 16, 17, 21 and 23 are obvious in view of Scholz.

2. I understand that, in challenging claims 1–23, Petitioner relies upon the Declaration of Dr. Richard W. Baker (AP 1003; the "**Baker Declaration**"). However, as explained in this Declaration, it is my opinion that statements made throughout the Petition and supporting Baker Declaration mischaracterize the

teachings of Ungerank in ultimately concluding that the claims 1–5, 7, 9, and 11–13 of the ‘380 Patent are obvious.

3. Accordingly, it is my opinion that the Petition fails to show that any of the challenged claims in the ‘380 Patent are unpatentable under, at least, Petitioner’s Ground 1.

II. Background Information

A. Professional Background and Qualifications

4. My professional background, qualifications, and experience testifying as an expert as set forth in my *curriculum vitae*, which is marked as Exhibit 2002. I also summarize pertinent aspects of my professional experience below.

5. As set forth in my CV, I have worked for over 25 years in the industry to which the ‘380 Patent applies. Based on my experience, I am familiar with the subject matter of the ‘380 Patent, namely, gas separation apparatuses and processes.

6. Since December 2013, I have been a managing director at Creonia e.U. focusing on the development, manufacturing, and application of high performance plastics with emphasis on membranes, gas separation with membranes, and biogas processing and upgrading.

7. From December 2013 through October 2014, I was a project employee at Gasaufbereitung Himmel GmbH where I was responsible for further

development and engineering of biogas upgrading processes, the optimal integration of the product into the customer's requirements, and the most process-optimized implementation of the technology in an economical and cost-efficient upgrading plant for biogas to biomethane. Between December 1997 and November 2013, I was a product developer and innovation manager at Evonik Fibres GmbH, where I was responsible for development projects in the fields of high performance plastics, films, and membranes in various application areas, including gas separation and biogas purification.

8. I received a graduate degree in technical chemistry from Graz University of Technology in 1993, with a focus on organic and macromolecular chemistry. I also completed a Doctor of Technical Sciences in 1996 at Graz University of Technology.

9. I have been named as an inventor on several United States patents all within the area of gas separation systems and methods, including U.S. Patent No. 8,999,038 B2 relied upon in the Petition.

B. Information Considered

10. In preparing this Declaration and formulating my opinions, I have reviewed the '380 Patent (AP-1001). I have been asked to assume that the earliest priority date of the '380 Patent is December 29, 2014.

11. I have also reviewed the Petition, the Declaration of Dr. Richard W. Baker submitted in support of the Petition (AP 1003), and the prior art references relied on therein, including U.S. Patent No. 8,999,038 to Ungerank et al. (AP-1006) and *Structural optimization of membrane-based biogas upgrading processes* authored by Scholz et al. (AP-1007).

12. I also base this Declaration on my knowledge from over 25 years of experience in gas separation methods and systems.

C. Scope of the Assignment

13. I have been asked by counsel for Patent Owner to provide my expert opinion on certain matters raised in the Petition and the Baker Declaration. This Declaration sets forth the opinions that I have reached to date regarding this matter.

D. Compensation

14. I am being compensated for my time spent in connection with this proceeding at my standard consulting rate. I am being separately reimbursed for any out-of-pocket expenses. No part of my compensation is dependent upon the outcome of this proceeding or the nature of the opinion that I express.

III. Person of Ordinary Skill in the Art

15. I have not been asked to opine on the definition of a person of ordinary skill in the art for purposes of this Declaration supporting Patent Owner's

preliminary response. I reserve the right to supplement and offer my opinion on the definition of a person of ordinary skill in the art as the proceeding progresses.

16. Nevertheless, in rendering my analysis, I have been asked to apply the skill level of a person of ordinary skill in the art that is proposed in the Petition, which is an individual with “a Master of Science degree in physical chemistry, chemistry, chemical engineering, or a related field, and at least three years of work experience in membrane gas-separation systems, including but not limited to biogas membrane separations” (Petition at 11; AP-1003, ¶¶56-60).

17. Under this definition, I was qualified as at least a person of ordinary skill in the art at the time of the invention.

IV. Claim Construction

18. I understand that claims are construed from the perspective of a person of ordinary skill in the art at the time of the earliest priority date of the patent. I understand that in the context of an *inter partes* review proceeding, absent a disclaimer or express definition, claim terms are given their plain and ordinary meaning to a person of ordinary skill in the art in view of the specification and file history. Unless otherwise noted, I have applied what I consider to be the plain and ordinary meaning of all terms as understood by a person of ordinary skill in the art at the time of the priority date of the ‘380 Patent.

V. Legal Principles

19. In formulating my opinions and conclusions in this proceeding, I have been informed by Patent Owner’s counsel of the legal standards that are relevant to my analysis.

20. I am informed that an *inter partes* review may not be instituted unless there is a reasonable likelihood that the petitioner would prevail with respect to at least one of the challenged claims. I am also informed that in an *inter partes* review proceeding, the Petitioner must prove patent invalidity by a “preponderance of the evidence,” which means more likely than not.

21. I am informed that a patent claim may be invalid as anticipated, either expressly or inherently, over the disclosure of a prior art reference, or as “obvious” in view of a combination of prior art references.

22. I am informed that in considering the issue of obviousness, I should consider what a person of ordinary skill in the art would have known as of the ‘380 Patent’s earliest effective filing date, i.e., December 29, 2014, as well as what a person would have reasonably expected to have been able to do in view of that knowledge.

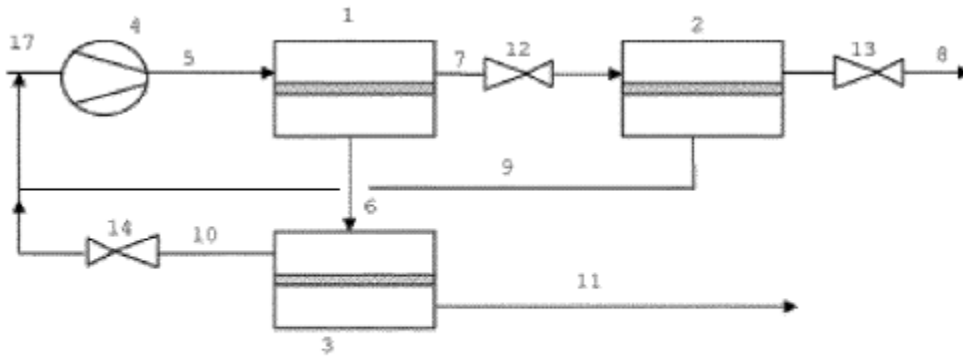
23. I am informed that an obviousness analysis requires evaluating the claim language as a whole, including comparing each and every limitation of the claim to the prior art.

24. I am informed that in analyzing the issue of obviousness, I should consider several factors including: (1) the scope and content of the prior art, (2) any differences between the claimed subject matter and the prior art, (3) the level of skill in the art, and (4) secondary considerations where in evidence.

25. I am informed that in order to show obviousness based on a single reference or a combination of references, a particular motivation to modify the reference or combine the teachings in the references, and a reasonable expectation of success must be shown.

VI. Overview of the '380 Patent

26. The '380 Patent is directed to a process and apparatus for the separation of gas mixtures. Specifically, the '380 Patent discloses and claims methods for separating gases from a crude gas stream comprising at least two components, with an apparatus comprising three stages: (1) a feed stream separation stage; (2) a retentate separation stage; and (3) a permeate separation stage.



Illustrative connection arrangement of several membrane modules according to invention

27. In reference to the Figure included in the ‘380 Patent, “[t]he feed stream separation stage (1) separates a feed stream (5) comprising at least two components into a first permeate stream (6) and a first retentate stream (7). The retentate separation stage (2) separates the first retentate stream (7) into a second permeate stream (9) and a second retentate stream (8), and the permeate separation stage (3) separates the first permeate stream (6) into a third retentate stream (10) and a third permeate stream (11).” (AP-1001, Col. 5:9–16.) The second permeate stream (9) and third retentate steam (10) are recycled and combined with the crude steam (17) to form the feed stream (5).

28. The ‘380 Patent provides permeate and retentate gases in high purities while optimizing investment, space, and maintenance costs, as opposed to optimizing energy consumption as addressed in prior art. (AP-1001, Col. 1:47–63.) In doing so, the methods recited in the ‘380 Patent claims rely on three features, namely (a) recycle volume; (b) membrane capacity; and (c) pressure-ratio quotient:

The inventors of the present invention surprisingly found, that beside of the energy optimum, as disclosed in WO 2012/00727, a maintenance cost optimum for three-stage membrane separation exists. This can be reached by

increasing the total gas volume recycled in sum with the second permeate stream (9) and the third retentate stream (10), in combination with

an increase of the total membrane capacity of the retentate separation stage (2) compared to the total membrane capacities of separation stage (1) and preferably also of stage (3), and

a specific quotient of the pressure ratios of the permeate separation stage (3) over the feed stream separation stage (1).

(AP-1001, Col. 2:27–40.)

29. I understand that the ‘380 Patent defines “membrane capacity” as “the product of the membrane surface and the permeance of the membrane at operating temperature that is determined for nitrogen (Grade 4.8) under standard conditions.”

(AP-1001, Col. 2:53–68.) In other words,

Membrane Capacity = Membrane Surface Area x Membrane Permeance

30. The ‘380 Patent further explains that “[i]f membranes of identical materials are operated in different separation stages and if the operating temperature is identical, their permeance is identical. As consequence, the ratio of membrane capacities used in two separation stages correlates to the ratio of the membrane surfaces. If, however, membranes out of different materials are used in different stages and/or if different membranes are used in one stage and/or if

different temperatures are used in different stages, the ratio of the capacities is usually different to the ratio of membrane surfaces.” (AP-1001, Col. 3:1–10.)

31. Based on this understanding, it is my opinion that Petitioner’s assertion that “[m]embrane area is...a proxy for ‘capacity’” may only apply where “membranes used in different stages have the same permeance, [such that] the stages’ capacity is equal to the ratio of the membranes’ areas.” (Petition at 9–10). In other words, membrane area can only be said to be a “proxy” for capacity in the limited instance where all membranes used in all stages of a multi-stage process have exactly the same permeance. Thus, contrary to Petitioner’s suggestion, membrane area is not always a “proxy” for membrane capacity.

32. The examples provided in the ‘380 Patent show that, compared to prior art processes (including that disclosed by WO 2012-00727,¹ included as Reference Example 1 in the ‘380 Patent), the process of the ‘380 Patent “can be operated with a significantly reduced overall membrane capacity to obtain similar purification results,” resulting in significantly reduced costs for the membranes. (AP-1001, Col. 2:20–26.) Specifically, at least, Example 1.1 demonstrates that increasing the “recycling rate,” “ratio of membrane capacity” and “quotient of the

¹ I understand that U.S. Patent Application No. 13/807,831, which matured into the Ungerank patent, is the U.S. National stage application of International Patent Application No. PCT/EP2011/058636, which was published as WO 2012-00727 and is referenced throughout the specification of the ‘380 Patent.

pressure ratio” of Reference Example 1 required a lower total membrane capacity (14.9% lower than Reference Example 1). “In other words, in the inventive set-up of the apparatus respectively process, invest cost could be reduced because the required total membrane capacity could be reduced.” (AP-1001, Col. 17:39–45.)

33. Notably, the processes and apparatuses disclosed in the ‘380 Patent do not rely on membrane selectivity, as they “produce high purity products even with membranes with a lower selectivity” in comparison to the “energy-optimized process of WO 2012/00727 [that] requires higher selective membranes” (AP-1001, Col. 2:43–47).

VII. Overview of Ungerank

34. I am an inventor of U.S. Patent No. 8,999,038 (AP-1006).

35. Ungerank provides a process configuration for a minimal energy consumption achieved through the use of higher selective membranes (i.e., with selectivities of more than 30, as claimed), and not simply through minimizing membrane capacity, reducing the number of membrane modules, or decreasing investment costs. At the time of the invention, I did not think, nor would a person of ordinary skill in the art have thought, that a higher recycled gas volume could result in a reduced number of membrane modules and/or the need for less membrane capacity. Nor was it understood that the total number of membrane modules could be reduced independent from membrane selectivity.

36. Similar to the ‘380 Patent, Ungerank is directed to apparatuses and processes for separating gases through a chain of gas separation membrane modules (AP-1006 at Abstract, claims 1, 12 and 34). However, the claims of Ungerank are directed to innovative apparatuses and processes configured to use a gas separation membrane module having a gas selectivity of at least 30 and being configured such that there is an increase of concentration of a first gas in the feed stream compared to its concentration in the crude gas stream and, providing a recycled gas volume of less than 60% by volume of the crude gas stream (AP-1006 at claims 1, 12 and 34).

37. Ungerank details the advantages of using high selectivity membranes within the claimed process, including, *inter alia*, that “the separation becomes more effective and less permeate has to be recycled from retentate separation stage (2), or less retentate from permeate separation stage (3). Thus, especially in the case of use of a one-stage compressor (4), it is necessary to compress less gas twice, which entails economic advantages in the operation of the plant.” (AP-1006 at Col. 9:14–20.) As a result, “the inventive operation can be conducted in a much more economically viable manner with more selective membranes, and the necessary size of the compressor and the energy required can be reduced.” (AP-1006 at Col. 9:31–34.)

38. Figure 11 of the '038 Patent depicts an arrangement of membrane modules according to the invention:

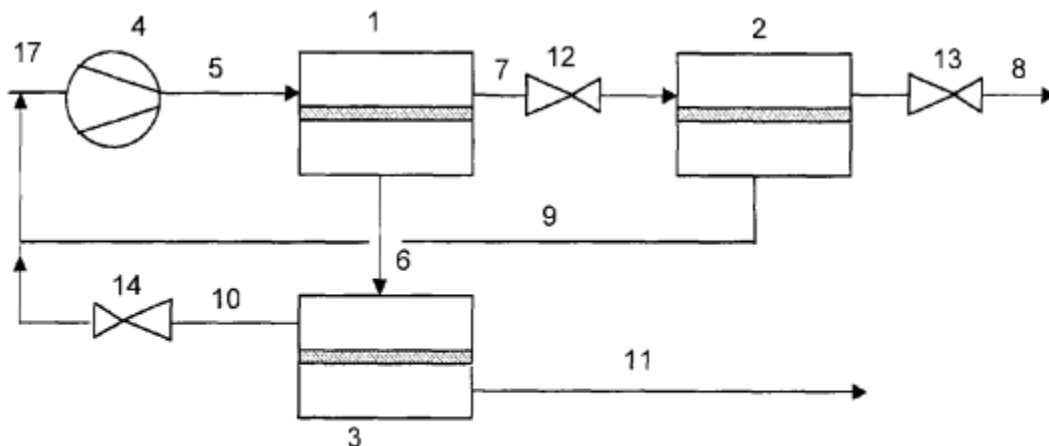


Fig. 11: Illustrative connection arrangement of several membrane modules according to invention

VIII. Opinion

39. As discussed below, in my opinion, numerous arguments made throughout the Baker Declaration and relied upon in the Petition are based on mischaracterizations of Ungerank, such that the Petition fails to show that claims 1-5, 7, 9 and 11-23 of the '380 Patent are unpatentable.

40. Specifically, the conclusions set forth in the Baker Declaration are grounded on the assertion that a person of ordinary skill in the art “would have been motivated to design a three-stage system with lower-selectivity membranes based on Ungerank’s Comparative Example 1, combined with the information on membrane surface are ratios...in Scholz’s Figure 7.” (Baker Decl. ¶ 119.)

41. However, in my opinion, a person of ordinary skill in the art would not look to Ungerank's Comparative Example 1 in seeking to arrive at the claims of the '380 Patent. The conclusions of the Baker Declaration to the contrary misinterprets the teachings of Ungerank.

42. The disclosure of Ungerank is specifically directed to the advantages over the prior art of three-stage gas separation processes and systems utilizing membranes of high selectivity. Indeed, not only do Ungerank's claimed inventive apparatuses and processes require higher selectivity membranes of at least 30, but Ungerank's disclosure, including Examples 1–4, explicitly demonstrates that membranes with higher selectivity are desirable in its three-stage processes.

43. Examples 1–4 of Ungerank, utilizing the connection arrangement of Figure 11 together with highly selective membranes (selectivity of 45), achieved both permeate and retentate streams of high purity and recycled gas volume of less than 60%. As a result, less gas is needed to be compressed twice and the energy required can be reduced, enabling a more economically favorable process. (*See* AP-1006 at Col. 9:31–34.)

44. In contrast, Comparative Example 1 demonstrates the effects of the use of a membrane with a lower selectivity (selectivity of 20) within the same connection arrangement and highlights the disadvantages the inventive processes of Ungerank sought to address. (AP-1006 at Col. 10:24–67.)

45. For example, a specific object of the processes disclosed in Ungerank is to be economically advantageous over the prior art. However, the process described in Comparative Example 1 of Ungerank resulted in a higher recycled gas volume (86.7%), requiring the recompression of a higher recycled gas volume and leading to higher operating costs as compared to processes using higher selective membranes. (See AP-1006 at Col. 10:24–67, 11:49–52; *see, e.g., id.* at Col. 11:49–52 (“The high selectivity of 45 compared to 20 in the comparative example therefore enables a more economically favorable process by a lower recompression of 31.2% rather than 86.7%.”).)

46. Accordingly, in my opinion, Ungerank teaches away from the process described Comparative Example 1. Indeed, a three-stage separation system utilizing a membrane selectivity of 20 and resulting in recycled gas volume of 86.7% is contrary to its specific teachings directed to a process using a membrane selectivity of at least 30 and having a recycled gas volume of less than 60%.

47. The Baker Declaration further asserts that “using lower-selectivity membranes was not inconsistent with Ungerank’s teachings, as Ungerank taught using higher-selectivity membranes to minimize operating costs, but with necessarily increased initial investment costs for higher-selectivity membranes.” (Baker Decl. ¶ 130.)

48. This assertion relies upon the assumption that lower-selectivity membranes are less expensive than higher-selectivity membranes. However, in my experience, use of lower selectivity membranes is not necessarily cheaper than use of higher selectivity membranes, and, in fact, can be more expensive. In my experience, there are many factors other than the selectivity of the membrane that affect the cost of a membrane. For example, a lower selective membrane having more separation capacity can be more expensive compared to a higher selective membrane.

49. In any event, even if the initial investment cost is less, over time, the operational costs would make such option less economically viable. As such, using lower-selectivity membranes is, in my opinion, inconsistent with the teachings of Ungerank.

50. Accordingly, in my opinion, a person of ordinary skill in the art “designing a system with lower-cost, lower-selectivity membranes” would not have looked to Ungerank’s Comparative Example 1 “in the first instance.” (Baker Decl. ¶ 131.) The conclusions of the Baker Declaration to the contrary are a misrepresentation of the teachings of Ungerank’s disclosure.

IX. Conclusion

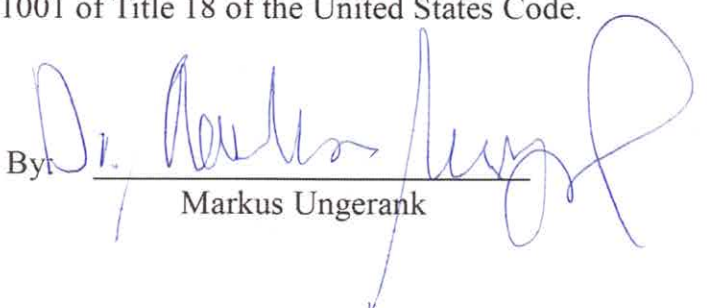
51. In my opinion, based on my review of the ‘380 Patent, the materials referenced above, and my knowledge of what a person of ordinary skill in the art

would have known at the time of the invention, the Petition fails to show that the claims of the '380 Patent are unpatentable.

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

Dated: June 14, 2024

By


Markus Ungerank