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D E C I S I O N
of 4 March 2004

Case Number: T 0262/00 - 3.4.2

Application Number: 93919347.0

Publication Number: 0656959

IPC: C25B 1/12

Language of the proceedings: EN

Title of invention:
Electrolysis apparatus for producing hydrogen

Patentee:
Fortum Oil and Gas Oy

Opponent:
LINDE AKTIENGESELLSCHAFT

Headword:
-

Relevant legal provisions:
EPC Art. 54, 56
EPC R. 67

Keyword:
"Inventive step, 2nd auxiliary request: yes"
"Novelty and reimbursement of appeal fee: not equitable"

Decisions cited:
-

Catchword:
-

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Case Number: T 0262/00 - 3.4.2

D E C I S I O N
of the Technical Board of Appeal 3.4.2
of 4 March 2004

Appellant: (Proprietor of the patent)
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Decision under appeal:
Interlocutory decision of the Opposition Division of the European Patent Office posted 28 January 2000 concerning maintenance of European patent No. 0656959 in amended form.

Composition of the Board:

Chairman: A. G. Klein
Members: A. G. M. Maaswinkel
C. Rennie-Smith

Summary of Facts and Submissions

I. The appellant (patent proprietor) lodged an appeal, received on 6 March 2000, against the interlocutory decision of the opposition division, dispatched on 28 January 2000, finding European patent No. 0 656 959 (based on application No. 93 919 347.0) as amended according to auxiliary request 2 to meet the requirements of the EPC. The fee for the appeal was paid on 6 March 2000. The statement setting out the grounds of appeal was received on 7 June 2000.

II. Opposition had been filed against the patent as a whole on the basis of Article 100(a) EPC in combination with Articles 52(1), 54 and 56 EPC. To support its objections the opponent referred to the following documents:

(D1) EP-A-0 478 980

(D2) Linde "Berichte aus Technik und Wissenschaft" Nr. 66, 1991, ISSN 0024-3728, pages 50 to 54, R. Glatthaar et al, "Konzept einer Hochleistungselektrolyse".

III. On 4 March 2004 oral proceedings were held as requested by both parties.

IV. At the oral proceedings the appellant requested that the decision under appeal be set aside and that the patent be maintained as amended on the basis of claim 1 of the main request filed on 7 June 2000 or, alternatively, of one of the auxiliary requests 1 (filed on the same date), 2 (filed during the oral

proceedings) or 3 (filed on 3 February 2004), and that the appeal fee be reimbursed.

V. The respondent (opponent) requested that the appeal be dismissed.

VI. Claim 1 of the main request reads as follows:

"An electrolysis apparatus for producing hydrogen by decomposing electrolytic liquid with the aid of electric current into hydrogen and oxygen in a closed pressurized electrolytic cell (11) placed within a pressure shell (10) filled with a liquid, and the pressure shell (10) is communicating with a gas source (16; 17) containing pressurized oxygen or hydrogen produced in the electrolytic cell (11) by a pipe line (24) so that the liquid in the pressure shell (10) is maintained pressurized by means of the pressure of the gas produced in the electrolysis
characterized in that
by said pipe line (24) the pressure of the product gas in the gas source is transmitted from said gas source (16; 17) directly to the liquid in the pressure shell (10) to thus directly control the pressure in the pressure shell (10), and
the pressure shell (10) is entirely filled with the liquid".

Claim 1 of the first auxiliary request reads as above with the additional feature at the end of its characterising portion:

"…and,

a pressure controller (35) is provided and connected to hydrogen and oxygen pressure sensors (26; 33), respectively
said pressure controller controlling the hydrogen and/or oxygen pressure responsive to the measurement results of said pressure sensors".

Claim 1 of auxiliary request 2 reads as follows:

"An electrolysis apparatus for producing hydrogen by decomposing electrolytic liquid with the aid of electric current into hydrogen and oxygen in a closed pressurized electrolytic cell (11) placed within a pressure shell (10) filled with a pressurizing liquid, and the pressure shell (10) is communicating with a gas source (16; 17) containing pressurized oxygen or hydrogen produced in the electrolytic cell (11) by a pipe line (24) so that the liquid in the pressure shell (10) is maintained pressurized by means of the pressure of the gas produced in the electrolysis
wherein,
by said pipe line (24) the pressure of the product gas in the gas source is transmitted from said gas source (16; 17) directly to the liquid in the pressure shell (10) to thus directly control the pressure in the pressure shell (10),
the pressure shell (10) is entirely filled with the pressurizing liquid which is kept separate from the electrolytic liquid, and
a pressure controller (35) is provided and connected to hydrogen and oxygen pressure sensors (26; 33), respectively

said pressure controller controlling the hydrogen and/or oxygen pressure responsive to the measurement results of said pressure sensors".

Claims 2 to 7 of this request are dependent claims.

The contents of the third auxiliary request are not relevant for the purpose of this Decision.

VII. The arguments of the appellant may be summarised as follows:

Claim 1 of the main request is based on the 1st auxiliary request, as discussed in the decision under appeal and against which no formal objections had been raised, with the additional feature defining the direct pressure control. Support for this feature is to be found in the embodiments of the patent and in particular page 5, 2nd paragraph of the published application. Therefore no formal objections against this claim should arise.

The subject-matter of claim 1 of this request differs from the electrolysis apparatus disclosed in document D1 in that the pressure control which is expressed in the features of the characterising portion of the claim is completely different. Via pipeline 24 the product gas molecules in the water separator interact directly with the molecules of the liquid in the pressure shell thereby directly transmitting and maintaining the pressure in the shell. In this way the pressure in the pressure shell is directly controlled without any electronic device being required. Document D1, see column 2, lines 23 to 26, discloses that the pressure

of the fluid in the pressure shell may be regulated directly or indirectly. Direct regulation is obtained by using hydrogen gas as a fluid, see the embodiment of Figure 2. However, according to D1, column 2, lines 40 to 46, indirect regulation by using feed water is preferred, since this medium can simultaneously transport the heat generated during the electrolysis process. By such use of feed water, if the pressure of the hydrogen gas in the separator A1 rises, the liquid level in the separator will change and this is detected and used as a control signal for regulating the fluid, see column 2, lines 26 to 32. As is shown in the embodiment in Figure 1 and disclosed in column 3, lines 47 to 52, the control signal is sent to pump P2 which, in case of a liquid level variation in hydrogen separator A1, transmits a corresponding water pressure via feed water pipe 10 to the pressure shell. Therefore in this apparatus the pressure control is indirect.

Also document D1 does not disclose or suggest the further feature in claim 1 that the pressure shell is entirely filled with the liquid. Since, in the embodiment of Figure 1 of D1, the feed water driven by pump P2 flows around the cell block via pipeline 10 to pipeline 8, the pressure shell does not have to be completely filled.

The objective problem underlying the invention resides in a simplification of the pressurization of the pressure shell compared to the embodiment of Figure 1 of D1 and simultaneously avoiding the pressure variations related to the use of a compressible medium which occur in the embodiment of Figure 2 of D1. Document D2 discloses essentially the same embodiment

as in Figure 1 of D1. As is shown in Figure 1 ("Bild 1"), the pump 12 receives the control signal from the sensor LIC measuring the liquid level in separator 3, thereby indirectly controlling the feed water pressure in the shell.

Claim 1 of the first auxiliary request contains the features of claim 1 of the 2nd auxiliary request not admitted by the opposition division (Annex 2 of the minutes of the proceedings) and, in addition to the features of claim 1 of the main request, clarifies how the pressure controller maintains direct pressure control. This further feature finds its support in the passage on page 6, line 28 to page 7, line 1 of the published application in connection with Figure 1. Although the apparatus in Figure 1 of D1 includes a pressure indication control, this is only used for controlling the valve in pipeline 6 and has nothing to do with controlling the pressure in the shell.

Claim 1 of the 2nd auxiliary request defines an arrangement in which the pressurizing liquid is kept separate from the electrolytic liquid, as is clearly and unambiguously derivable from Figure 1 in conjunction with the description of the apparatus on column 4, line 21 to column 5, line 5 of the patent specification. This arrangement differs fundamentally from the embodiments in D1 and D2. In particular, in the embodiment in Figure 1 of D1, the feed water used for pressurizing is mixed with the electrolyte which, according to the teaching of D1, is advantageous because in this arrangement the feed water can also function as a heat exchanger. The skilled person would have no incentive to dispense with this advantage. In

the embodiment of Figure 2 of D1, hydrogen is used as a pressurizing fluid which is not a liquid. The objective problem addressed by this difference over the prior art can be seen in improving that system against corrosion, see column 3, lines 4 to 12 and particular line 6 of the patent specification, where it is disclosed that even the use of ion-exchanged water may be problematic. Since, in the embodiment of Figure 1 of D1, feed water is used and the problem of corrosion is not mentioned, it follows that this problem was not recognised in that document. Indeed, according to D1, column 1, line 56 to column 2, line 4, all electrically non-conducting fluids may be used with the proviso that their use does not require any modifications to the construction of the electrolytic cell or the pressure shell, and the use of completely desalted feed water is particularly recommended. Therefore the skilled person would have no incentive to modify the apparatus of D1 by separating the pressurizing liquid from the electrolytic liquid as defined in claim 1.

The request for reimbursement of the appeal fee arises from a substantial procedural violation committed by the opposition division during the oral proceedings. In these proceedings the patent proprietor submitted two auxiliary requests (Annexes 1 and 2 to the minutes of those oral proceedings). Auxiliary request 2 (Annex 2) was held inadmissible by the opposition division since, according to the chairman, the additional features of this request had been taken from the description and probably had not been searched and, furthermore, the subject-matter of this claim was not clearly allowable under Rule 71a EPC. Furthermore the opposition division based its reason for the inadmissibility of the 2nd

auxiliary request on Internal Guidelines in the EPO, which are not known to and were not presented to the parties. Although it is established Case Law of the Boards of Appeal that the admissibility of amended claims presented during oral proceedings is a matter for the discretion of examining and opposition divisions, this discretion should only be exercised against a patentee if the amendments are not necessary and appropriate to overcome the objections raised. Since in the present case the opposition division indicated that the subject-matter of the main and 1st auxiliary requests was not new, it should have found the 2nd auxiliary request admissible because this was more restricted in order to overcome the objections. Furthermore, Rule 71a EPC does not apply to amendments submitted during oral proceedings. For these reasons, the request for reimbursement of the appeal fee is justified.

VIII. The arguments of the respondent may be summarised as follows:

For all requests both documents D1 and D2 may be considered as the closest prior art. The definition of "direct control" given by the appellant, namely that the product gas molecules in the water separator interact directly with the molecules of the liquid in the pressure shell, applies equally to the apparatus disclosed in D1 and in D2. In the embodiment of Figure 1 of D1 the gas molecules in the oxygen separator A2 interact directly with the water molecules of the liquid in pipeline 24 which is in open contact with the pressure shell 2. The apparatus in document D2 includes the same open connection between the pressure

shell and the separator. In both documents, as well as in the patent in suit, the pressure control is achieved exclusively by means of the respective pressure control valves: in Figure 1 of document D1, by the valves in the pipelines 6 and 7 of the water separators; in D2 ("Bild 1") by the water separators 3 and 4; and in the patent, by the water separators 16 and 17. See claim 4 of D1, which specifies that the pressure of the electrically nonconductive fluid is controlled via the pressure of one or both product gases. See also page 51, central paragraph of D2, where it is explained that the oxygen valve is for maintaining the pressure within the apparatus and the hydrogen valve ensures equal pressure within both separators. Since neither documents D1 and D2 nor the patent disclose any further valves or pressure reducers within the systems, it is inevitable that the pressure at each and every point within the respective systems is the same.

The argument of the appellant that in the embodiment of Figure 1 of D1 the pressure control is indirect by means of the pump P2 is not correct. The function of this pump is only to provide feed water to the system in order to maintain the desired fluid level in the separators A1 and A2, this pump therefore being equivalent to pump 19 in Figure 1 of the patent in suit. This also follows from the level indication control LIC which detects the fluid level and sends a signal to the pump 2 if, by the consumption of feed water during the electrolysis process, the water level in the separator becomes too low.

Furthermore, the electrolysis apparatus disclosed in D1 and in D2 also include the feature that the shell is

entirely filled with the liquid, because the shell must always be completely full of feed water in order that this can flow through the pipeline supplying water to the required level in the separators. Therefore the subject-matter of claim 1 of the main request is known from document D1 as well as D2.

The further feature of claim 1 according to the 1st auxiliary request defining the pressure controller is, as set out above, equally disclosed in documents D1 and D2, since this pressure controller is essential for controlling the pressure in the devices. More particularly, in D1 this controller is shown as the pressure indication control PIC regulating the opening/closing of the valves; and in Figure 1 of document D2 it is shown by the letters PDIC (pressure differential indication control).

As for claim 1 of the 2nd auxiliary request reference is made to column 1, line 56 to column 2, line 2 of document D1 where the general concept of that invention is disclosed. According to this passage, all electrically nonconducting and inert fluids may be used for the pressurization in the pressure shell unless they lead to corrosion of the electrolysis cell or pressure shell. Therefore the skilled person would contemplate applying further alternative fluids to those in the particular embodiments in Figures 1 and 2 of D1. For instance, in the embodiment in Figure 2 the pressure shell is entirely filled with the fluid (hydrogen) which is kept separate from the electrolytic liquid. It is obvious that if the skilled person would prefer to apply an alternative pressurizing medium, for instance oil, in that particular embodiment the oil in

the pressure shell would be kept separate from the electrolytic liquid. Also, when using a different pressurizing liquid in the embodiment of Figure 1, for instance oil, the skilled person would as a matter of course take care that this liquid did not mix with the electrolyte liquid used in the electrolytic cell since such contaminated electrolyte would destroy the cell. Therefore the subject-matter of claim 1 of this request follows in an obvious way from the general disclosure of document D1 when combined with its particular embodiments.

Reasons for the Decision

1. The appeal is admissible.

2. *Main request*

2.1 Amendments

The board is satisfied that the amendments in claim 1 are fairly supported by the passages in the original application documents referred to by the appellant.

2.2 Novelty

2.2.1 Document D2, see Figure 1 ("*Bild 1*") on page 51, discloses an electrolytic apparatus for producing hydrogen by decomposing electrolytic liquid (*KOH mixed with purified water*) with the aid of electric current into hydrogen (H_2) and oxygen (O_2) in a closed pressurized electrolytic cell (1) placed within a pressure shell (2) filled with a liquid (*purified*

water), and wherein the pressure shell (2) is communicating with a gas source (*separator 4*) containing pressurized oxygen produced in the electrolytic cell (1) by a pipeline (*schematically shown in Figure 1*) so that the liquid in the pressure shell (2) remains pressurized by means of the gas (*oxygen*) produced in the electrolysis. There is agreement among the parties that these features forming the preamble of claim 1 are known from the disclosure of D2 as well as that of D1.

2.2.2 With respect to the feature that "by the pipeline the pressure of the product gas is transmitted from the gas source *directly* to the liquid in the pressure shell to thus *directly control* the pressure in the pressure shell", the appellant has argued that the term "*directly*" implies a direct interaction of the product gas molecules with the molecules of the liquid in the pressure shell thus transmitting and maintaining the pressure within the pressure shell, and thereby rendering any further electronic control of the pressure unnecessary. According to the appellant this idea is not disclosed or suggested in the prior art, because in D1, Figure 1, the pressure in the pressure shell is determined by the water feed pump which is controlled by a sensor LIC sensing the level in the water separator A1, and in the embodiment in D2, Figure 1, by a corresponding pump 12. In the opinion of the respondent, the pressure control in the apparatus in all of D1, D2 and the patent in suit is controlled by actuating the valves, since the systems are open systems without any further valves or pressure reducers within the systems.

2.2.3 According to D2, page 50, right column, penultimate paragraph, in the electrolysis apparatus shown in Figure 1 the function of pump 12 is to regulate the liquid level in the communicating separators 3 and 4 so that it remains constant. It is understood that this liquid level is sensed by the sensor LIC (*level indication control*). Furthermore, as pointed out by the respondent, on page 51, central paragraph it is disclosed that the valve in the oxygen output duct ensures the maintenance of the pressure in the apparatus (*see the pressure indication control "PIC", connected to the O_2-valve by the schematic dashed line in Figure 1*) and that the valve in the hydrogen output duct has the function of keeping the same gas pressure in the H_2 and O_2 separators (*by means of the PDIC - pressure differential indication control*). Since in the apparatus of D2, Figure 1, the pressure shell is "communicating" with the gas source (*as defined in the preamble of claim 1 and acknowledged by the parties*) and there is an open connection between the pressure shell, the O_2-separator (*schematically shown in Figure 1 by the line connecting the top of the shell and the separator*) and the output duct from the O_2-separator to the O_2-valve, it follows on basic physical principles that the pressure within these parts must necessarily be the same, and that by opening/closing the O_2-valve the pressure in the pressure shell is controlled, as disclosed in document D2, page 51, central paragraph.

2.2.4 The appellant argued that in the apparatus of document D1, see column 3, lines 47 to 52, the pressure in the pressure vessel was controlled by measuring the liquid level in the separator A1 and issuing a signal to pump P2. Since the apparatus in D2 was essentially the same

as that in Figure 1 of D1, the pressure control and regulation in that apparatus should be similar, i.e. via pump 12. During the oral proceedings the appellant asserted that, if the pressure of the hydrogen gas in the separator A1 in Figure 1 of D1 rises, the liquid level in the separator will change, which is detected and used as a control signal for regulating the fluid. This argument does not appear persuasive: since the pressurizing fluid in the embodiment of Figure 1 of D1 (and similarly in D2) is a liquid, water, this medium can be considered as essentially incompressible, and a variation of the hydrogen pressure in the separator A1 should not have a measurable effect on the level of the gas/liquid interface. In any case, the disclosure in document D2, see in particular Figure 1 and the cited passages, leaves no doubt that the pressure in the pressure shell and in the connected O_2-ducts is the same and that it is controlled by the O_2-valve, whence the claimed feature is disclosed in this document.

2.2.5 Concerning the feature in claim 1 that "the pressure shell is entirely filled with the liquid", document D2 discloses on page 50, left column, 2nd paragraph "the (*electrolytic*) cells …are arranged in a pressure shell, which is filled with feed water". Furthermore, inspection of Figure 1 of D2 and the associated description of Figure 1 ("*Bild 1*") on page 50, right column, shows that the water is pumped by pump 12 via the pressure shell 2 into the O_2-separator, leaving the pressure shell at its highest point and entering the separator at its top opening. Therefore it follows that the pressure shell is *entirely* filled with the water.

2.2.6 The subject-matter of claim 1 according to the main request is therefore known from document D2 and the main request is not allowable (Article 52(1) and 54 EPC).

3. *First auxiliary request*

3.1 Amendments

The additional features of claim 1 of this request concern the pressure controller (35) connected to the hydrogen (26) and oxygen pressure sensors (33). The feature finds its support in Figure 1 and page 6, last paragraph of the original application. Therefore there are no formal objections to this claim.

3.2 Novelty

3.2.1 As set out in point 2.2.3 *supra*, in the embodiment of Figure 1 of D2, the apparatus comprises an oxygen pressure sensor (*PIC*) and a hydrogen/oxygen differential pressure sensor (*PDIC*) which control the respective pressures (*page 51, center column*). Therefore the subject-matter of claim 1 according to this request is not new having regard to document D2.

4. *Auxiliary request 2*

4.1 Amendments

Claim 1 of this request has the further feature that the pressurizing liquid in the pressure shell *is kept separate from the electrolytic liquid*. Support for this feature is implicit in Figures 1 and 2 and the passages

in the patent specification referred to by the appellant, which correspond to page 5, line 26 to page 6, line 26 of the published application. The claim is further restricted than claim 1 as granted, therefore the provisions of Article 123(2) and (3) EPC are met. Nor does the new wording give raise to any objections under Article 84 EPC.

4.2 Novelty

4.2.1 Document D1

In the embodiment of Figure 1 of D1 the feed water is mixed with the electrolyte (*see also column 3, lines 36 and 37; and lines 55 and 56*). In the embodiment of Figure 2 of this document the pressurizing fluid is hydrogen, which is not a liquid. Therefore the subject-matter of claim 1 according to this request is novel having regard to D1.

4.2.2 Document D2

Similar to the arrangement of Figure 1 of D1, in the apparatus of Figure 1 of D2 the feed water is mixed with the electrolyte in the separator 4.

4.2.3 There are no closer citations in the file. Thus, the electrolytic apparatus defined in claim 1 of the 2nd auxiliary request is novel over the prior art.

4.3 Inventive step

4.3.1 According to the appellant, the objective problem underlying the arrangement defined in claim 1, which

differs from the prior art in that the pressurizing and electrolytic liquids are separated, resides in improved protection of the apparatus against corrosion.

4.3.2 Document D1

The respondent has made reference to the passage in column 1, line 56, in particular line 58 of document D1, where it is disclosed that any electrically nonconducting or inert fluids may be used in the pressure shell as long as no particular anti-corrosion measures are required in the electrolysis cell or the pressure shell. It follows that the problem of corrosion of electrolysis apparatus *as such* was known from document D1.

4.3.3 Therefore the question should be addressed, would the skilled person have had any obvious reason to modify the apparatus disclosed in D1 to include the features of claim 1? In this respect the passage in column 2, lines 3 and 4 of D1 (immediately following that cited above) is noted. According to this, it is particularly advantageous for the electrolysis apparatus to use feed water (completely desalted water); and indeed in the embodiment of Figure 1 of D1 feed water is employed for pressurizing the pressure shell. The skilled person would therefore conclude that, although corrosion is a problem to keep in mind in the selection of a fluid, the employment of desalted (deionised) feed water is recommended. Thus, the above-cited passages in D1 would not lead the skilled person to modify the pressurizing medium, in particular because this would require not only the selection of an alternative pressurizing fluid (*for which, apart from the choice of hydrogen which is*

a gas, D1 does not disclose any alternatives) but also modification to the piping and feedwater supply of the apparatus. Even if it was assumed that the skilled person would have contemplated using a **separate** liquid, the respondent did not satisfy the board why the skilled person would nonetheless maintain the direct connection between the pressure shell 2 and the O_2-separator A2 via pipe 8, which in the apparatus of document D1 is primarily provided for circulating the **same** liquid from the pressurizing shell to the O_2-separator, from where it then enters the electrolytic cell. Therefore modification of the embodiment of Figure 1 of document D1 in the manner now claimed would not appear obvious.

4.3.4 In the embodiment in Figure 2 of D1 hydrogen gas, which is not a liquid, is used as a pressurizing medium. According to document D1, column 2, lines 31 to 42, the use of hydrogen gas has specific advantages because it simplifies the pressure control.

Therefore it appears that D1 presents each of the two embodiments in Figures 1 and 2 as having its own specific advantages, and it is not *a priori* plausible why, and if so, how the skilled person *would* have modified either of those embodiments in the manner defined in claim 1 of the 2nd auxiliary request.

4.3.5 Document D2

The observations made regarding Figure 1 of D1 apply similarly to the apparatus in Figure 1 of D2. According to D2, page 50, right column, penultimate paragraph, the ionic conductivity of the feed water is precisely

specified. No conditions or restrictions for avoiding corrosion are disclosed; indeed neither the problem of corrosion, nor any related modification is disclosed or suggested. It does not therefore appear obvious why the skilled person should envisage modifying the apparatus of D2 to arrive at the subject-matter of claim 1.

4.4 It is therefore concluded that claim 1 of the 2nd auxiliary request meets the provisions of Article 52(1) EPC.

4.5 Claims 2 to 7 are dependent claims and equally fulfil these provisions.

5. *Request for reimbursement of the appeal fee*

In accordance with Rule 67 EPC, reimbursement of an appeal fee may only be ordered when an appeal is allowable and if such reimbursement is equitable by reason of a substantial procedural violation. In the present case, the main request before the board was substantially broader in scope than the one found inadmissible by the opposition division (*i.e. the 2nd auxiliary request filed at the oral proceedings before the opposition division*). In order to have such a broader request considered, the appellant would have had to file an appeal even if the opposition division had admitted the request it rejected as inadmissible. For this reason alone, reimbursement of the appeal fee would not be equitable, and the request must be refused accordingly.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the first instance with the order to maintain the patent on the basis of claim 1 of the auxiliary request 2 filed during the oral proceedings, claims 2 to 7 as granted, the description as filed during the oral proceedings, and the drawings as granted.

3. The request for reimbursement of the appeal fee is dismissed.

The Registrar: The Chairman:

P. Martorana A. Klein