Internal distribution code:

(A) [-] Publication in OJ
(B) [-] To Chairmen and Members
(C) [-] To Chairmen
(D) [X] No distribution

Datasheet for the decision of 2 February 2023

Case Number: T 0506/20 - 3.2.05

Application Number: 13733002.3

Publication Number: 2877337

IPC: B29C70/44, B29C70/54, B29L31/08

Language of the proceedings: EN

Title of invention:
Method and moulding system for manufacturing a fibre-reinforced polymer object via a feedback system for controlling resin flow rate

Patent Proprietor:
LM Wind Power A/S

Opponent:
Vestas Wind Systems A/S

Relevant legal provisions:
EPC Art. 54(1), 54(3), 56

Keyword:
Novelty - auxiliary request 2 (yes)
Inventive step - auxiliary request 2 (yes)

Decisions cited:
T 0153/85, T 1110/03

Europäisches Patentamt
European Patent Office
Office européen des brevets

Beschwerdekammern

Boards of Appeal

Chambres de recours

Boards of Appeal of the
European Patent Office
Richard-Reitzner-Allee 8
85540 Haar
GERMANY
Tel. +49 (0)89 2399-0
Fax +49 (0)89 2399-4465

Case Number: T 0506/20 - 3.2.05

D E C I S I O N
of Technical Board of Appeal 3.2.05
of 2 February 2023

Appellant II: (Patent Proprietor)	LM Wind Power A/S Jupitervej 6 6000 Kolding (DK)
Representative:	COPA Copenhagen Patents Rosenørns Allé 1, 2nd floor 1970 Frederiksberg C (DK)
Appellant I: (Opponent)	Vestas Wind Systems A/S Hedeager 42 8200 Aarhus N (DK)
Representative:	Callaghan, Mark Peter Keltie LLP No.1 London Bridge London SE1 9BA (GB)
Decision under appeal:	**Interlocutory decision of the Opposition Division of the European Patent Office posted on 19 December 2019 concerning maintenance of the European Patent No. 2877337 in amended form.**

Composition of the Board:

Chairman	P. Lanz
Members:	B. Spitzer
	C. Brandt

Summary of Facts and Submissions

I. The patent proprietor and the opponent have each lodged an appeal against the interlocutory decision of the opposition division finding that European patent No. 2 877 337 (the patent) as amended according to auxiliary request 3 meets the requirements of the EPC.

II. The opposition was filed against the patent as a whole based on the grounds for opposition set out in Article 100(a) EPC, for lack of novelty and lack of inventive step, and Article 100(b) EPC.

III. Requests

Appellant I (opponent) requested that the decision under appeal be set aside and the patent be revoked.

Appellant II (patent proprietor) requested that the decision under appeal be set aside and the patent be maintained as per auxiliary request 2 submitted with its statement of grounds of appeal, or, as auxiliary measures, that the opponent's appeal be dismissed, i.e. that the patent be maintained as per auxiliary request 3, or that the decision under appeal be set aside and the patent be maintained as per one of auxiliary requests 3A, 4 to 12, 6A, 7A, 9A or 11A submitted with its reply to the statement of grounds of appeal on 7 September 2020, the auxiliary requests being ranked in the following order: 2, 3, 3A, 4, 5, 6, 6A, 7, 7A, 8, 9, 9A, 10, 11, 11A, 12.

IV. The following documents are relevant for this decision:

E1: WO 2013/072074 A1, published 23 May 2013, filed 10 February 2012;
E2: WO 2009/103736 A2;
E3: EP 2 404 743 A1;
E4: US 2007/0145622 A1;
E5: Extracts from "Process Modeling in Composites Manufacturing", Second Edition, published 14 July 2010, including title pages and pages 414-429;

E8: US 2005/040553 A1;
E9: GB 2 403 927 A;

E10: Series of publications linked to Magnum Venus Plastech, including:
E10A: EP 1 452 845 A2, "Pressure measurement system", Plastech Thermoset Tectonics Limited, published 1 September 2004;
E10B: "RTM Today" published by Plastech Thermoset Tectonics Limited, Spring 2004 edition;
E10C: Pages 4 and 5 extracted from "RTM Today", Spring 2004 edition;
E10D: "RTM Today" published by Plastech Thermoset Tectonics Limited, Autumn 2004 edition;
E10E: "RTM Today" published by Plastech Thermoset Tectonics Limited, Winter 2005 edition;
E10F: "RTM Today" published by Magnum Venus Plastech, Spring 2007 edition;
E10G: Product specification for "PV Sensor System", published by Magnum Venus Plastech in 2007;
E10H: Product specification for "Megaject Sprinter SSB", published by Magnum Venus Plastech in 2007;
E10I: Extract from online article "A better way to

infusion mold blades", published at https://www.windpowerengineering.com/construction/a-better-way-to-infusion mold-blades/ on 8 June 2010;

E10I': Screenshot of a Wayback Machine capture of E10I

E10J: "Flex molding process" brochure, published by Magnum Venus Plastech in 2010;

E10K: Nida-Core Corp, presentation, dated February 2009;

E10K': Screenshot of a Wayback Machine capture of E10K;

E11: Series of publications linked to Composite Integration Ltd., including:

E11A: Article from "Reinforced Plastics", "The crossover from RTM to resin infusion", published October 2008;

E11B: "Developments in closed-mould process control", presentation delivered by Composite Integration at "Composites Innovation 2010" in Manchester, UK at 11.30 hrs on 10 November 2010;

E11C: Event programme for "Composites Innovation 2010";

E11D: A redacted email dated 19 February 2018 providing further evidence of the prior-art status of E11B;

E14: US 2003/0116262 A1;

D12: "An introduction to composites recycling" in "Management Recycling and Reuse of Waste Composites", Woodhead Publishing, January 2014.

V. The independent claims of auxiliary request 2 have the following wording:

"1. A method of manufacturing a fibre-reinforced polymer object by means of vacuum-assisted resin transfer moulding (VARTM), wherein fibre material is impregnated with liquid resin in a mould cavity comprising a rigid mould part (13) having a mould surface (14) defining an outer surface of the object, said method comprising the following steps:
a) arranging a fibre lay-up (16) including a number of fibre layers on the mould surface,
b) arranging at least one resin inlet (27; 27') above the fibre lay-up (16),
c) attaching one or more pressure sensors (60) to the at least one resin inlet (27, 27'),
d) arranging a vacuum bag (43) on top of the rigid mould part (13) and sealing the vacuum bag (43) to the mould part (13) to define the mould cavity,
e) evacuating the mould cavity,
f) supplying liquid resin to the mould cavity so as to impregnate the fibre lay-up (16),
g) monitoring the pressure and generating a signal indicative of said pressure,
h) feeding said signal back to a control unit (62) that controls a resin flow rate supplied to the resin inlets (27; 27'),
i) increasing a resin flow rate, if the pressure measured by the pressure sensors (60) at the resin inlet (27; 27') drops below a lower threshold level, and decreasing the resin flow rate, if the pressure measured by the pressure sensors (60) at the resin inlet (27; 27') is above a higher pressure threshold, and
j) allowing resin to cure so as to form the fibre-reinforced polymer object."

"8. A moulding system comprising:
- a rigid mould part (13) having a mould surface (14) defining an outer surface of a fibre-reinforced polymer object moulded in said system,
- a vacuum bag (43) for sealing against the rigid mould part (13) so as to form a mould cavity,
- a vacuum source connected to the mould cavity so as to evacuate the mould cavity,
- one of [*sic*] more resin inlets (27, 27', 36-42, 46-52) connected to the mould cavity, and
- a polymer supply unit (64) connected to the resin inlets and adapted to supply resin to the resin inlets, wherein the system further comprises:
- one or more pressure sensors (60) connected to the resin inlets, the pressure sensors (60) being adapted to measure a pressure in the resin inlets and generating a signal indicative of the measured pressure, and
- a control unit (62) for controlling the polymer supply unit (64) based on said signal and adapted to increasing a resin flow rate, if the pressure measured by the pressure sensors (60) at the resin inlet drops below a lower threshold level, and decreasing the resin flow rate, if the pressure measured by the pressure sensors (60) at the resin inlet is above a higher pressure threshold."

VI. The submissions of the parties relevant to the decision can be summarised as set out below.

(a) Auxiliary request 2: novelty of the subject-matter of claims 1 and 8 in view of document E1

(i) Patent proprietor

The subject-matter of claims 1 and 8, for which the priority was validly claimed, was new over document E1.

Document E1, which was prior art under Article 54(3) EPC for claims 1 and 8 of auxiliary request 2, did at least not disclose a vacuum bag for sealing against the rigid mould part so as to form a mould cavity.

A vacuum bag was not an implicit feature of the VARTM process disclosed in document E1.

The opposition division found that the presence of a vacuum bag was implicit for a VARTM process (see decision under appeal, Reasons, point 4.2.1.1). This was not correct since it was not immediately apparent to the person skilled in the art that nothing other than a vacuum bag was disclosed in document E1. However, this was a requirement for novelty (see Case Law of the Boards of Appeal of the European Patent Office, 9th edition 2019 (Case Law, 9th edition), I.C. 4.3). The person skilled in the art had to be unable to conceive of any realistic alternative to the allegedly implicit feature (see decision T 287/16). The opposition division's statement that "*VARTM is characterized by the use of a vacuum bag to perform the process*" (see decision under appeal, Reasons, point 4.2.2) was not a substantiation. Importantly, several realistic alternatives existed to using a vacuum bag,

e.g. a vacuum membrane press prior to applying the vacuum or a sealed matched tool (see document D12, page 8, bullet point "Vacuum assisted RTM (VARTM)"). The opposition division's remarks that document D12 related to "*the waste management of composites with a vague reference to VARTM that cannot be considered as a proper technical definition of the mentioned process for the manufacturing of windmill blades*" (see decision under appeal, Reasons, point 4.2.2) did not match the actual text of document D12 on page 8, where the manufacturing of wind turbine blades was explicitly mentioned. For this reason, document D12 was relevant to this field.

In addition, document E1 itself suggested that no vacuum bag was used but instead that a sealed matched tool was used (see document E1, page 3, lines 16 to 18): "*upper and lower mold halves are tightly connected with each other [...]*". This passage in document E1 could not be interpreted as describing a process using an internal vacuum bag, as per document E14 and the opponent's argument, since there was no apparent link between documents E1 and E14. There was no justification to construe this passage in a manner that deviated from its clear meaning.

Document E2 confirmed this understanding that VARTM processes were not limited to using a vacuum bag as it revealed that a second mould part was often made of a resilient vacuum bag, indicating that this practice was not consistently done (see document E2, page 3, lines 27 to 29).

In addition, documents E8 and E9 cited by the opponent as evidence of prior-art VARTM did not use a vacuum bag (see document E8, Figure 1B: chamber 104 and paragraph

[0021] and document E9: page 4, last paragraph and Figure 1: upper semi-rigid skin 20).

Document E5, cited in favour of the opponent's case, referred to "'vacuum bagged' vacuum-assisted resin transfer moulding (VARTM)" as a single-sided moulding process (see document E5, page 418, last paragraph and Figure 8.24). This solely confirmed that vacuum bagging was one way of carrying out VARTM but evidently not the only one.

Document D12 constituted evidence of the common general knowledge.

Even though document D12 was a post-published document and thus as such not part of the prior art, it was submitted as evidence of the prior art and in substantiation of facts relevant to the issue of novelty (see decision T 1110/03). Despite its slightly later publication date, document D12 might be considered to reflect the common general knowledge at the priority date of the patent that a sealed matched tool was a possible alternative to a vacuum bag in a VARTM manufacturing process for wind turbine blades. In line with settled case law, a technical review article was by definition an account of the common general knowledge in the art prior to its own publication date (see Case Law, 9th edition, I.C.2.8.5.).

The content of document E2 was not part of the disclosure of document E1.

Document E2 disclosed the missing features, especially the vacuum bag. However, despite the reference in document E1 to document E2, document E2 did not form part of the disclosure of document E1. The Guidelines

for Examination (see Guidelines for Examination in the European Patent Office, March 2022, G-IV, 8) detailed the criteria that had to be met for a document to be considered incorporated by reference: "*If a document (the "primary" document) refers explicitly to another document (the "secondary" document) as providing more detailed information on certain features, the teaching of the latter is to be regarded as incorporated into the primary document if the document was available to the public on the publication date of the primary document (see T 153/85)*". The reference to document E2 in document E1 (see document E1, page 1, line 19) did not pertain to the characteristics of the invention disclosed in document E1. Instead, document E2 was referenced in the introductory background section of document E1 only as an example of a VARTM process. The person skilled in the art would not have understood that this constituted a reference to one or more specific features disclosed in document E2 and forming part of the invention of document E1.

(ii) Opponent

The subject-matter of claims 1 and 8 was not new over document E1. Document E1 disclosed all the features of claims 1 and 8, including the vacuum bag.

A vacuum bag was an implicit feature of the VARTM process disclosed in document E1.

Document E1 disclosed a VARTM arrangement for manufacturing wind turbine blades. As such and in line with the opposition divisions' finding, a vacuum bag was an implicit feature of a VARTM process. Therefore, document E1 implicitly disclosed a vacuum bag (see decision under appeal, Reasons, point 4.2.2). The test

for an implicit disclosure did not only ask whether the person skilled in the art could conceive of an alternative to a vacuum bag but further whether the person skilled in the art would consider the alternative to a vacuum bag suitable for use in making wind turbine blades and whether the use of such an alternative would still be considered VARTM.

The passage in document E1, where upper and lower mould halves were mentioned (see document E1, page 3, lines 16 to 18), did not teach away from using a vacuum bag. This passage pertained to a unique "one shot" process for manufacturing wind turbine blades, as disclosed in document E14 which involved an internal vacuum bag.

Documents E2, E5, E8, E9 all referred to vacuum bags in VARTM processes. Despite its generic language which was common in patent applications, document E2 explicitly disclosed the use of a vacuum bag and did not propose any particular alternative (see document E2, page 3, lines 27 to 29). The textbook E5 discussed the basics of VARTM and affirmed that a vacuum bag was implicit to a VARTM process (see document E5, Figure 8.24 (a) on page 120; paragraph spanning pages 418 and 419). Document E8 addressed problems both in RTM and VARTM systems. This was why document E8 referred broadly to a "chamber" without entailing the construction of the chamber. Especially paragraph [0021] of document E8 noted that the chamber was typically flexible when vacuum was used. Document E9 did not show a VARTM system but an RTM system, albeit one that used vacuum pumps (see document E9, page 3, line 8). So, the patent proprietor had failed to provide a single example in the prior art of a VARTM system for making wind turbine blades in which no vacuum bag was used.

Besides the fact that document D12 was not part of the state of the art, document D12 did not disclose the use of a "sealed matched tool" in the context of a VARTM process for making wind turbine blades, as alleged by the patent proprietor. Document D12 was concerned with recycling composite products and did not provide relevant teaching for manufacturing processes of composite materials for wind turbine blades. The passage of document D12 which related to the VARTM process was very short and, thus, less relevant than the detailed disclosure of document E5. Therefore, document D12 did not contradict the opinion of the opposition division that the use of a vacuum bag is implicit in the VARTM process of document E1 for manufacturing a wind turbine blade.

Document D12 did not constitute evidence of the common general knowledge.

Document D12, which the patent proprietor referred to, did not constitute prior art as its publication date was after the priority date of the patent (see also decision under appeal, Reasons, point 4.2.2). Therefore, document D12 could not offer a reliable indication of the common general knowledge of the person skilled in the art at the priority date. Document D12 did not prove that using a "sealed matched tool" in a VARTM process was available and known to the person skilled in the art at the priority date of the patent.

The content of document E2 was part of the disclosure of document E1.

The VARTM arrangement disclosed in document E2 was implicitly part of the disclosure of document E1 by

virtue of the reference to document E2 in document E1. Document E1 described a system for feeding a composite fluid into a VARTM mould and stated that the system it described was to be used with known VARTM arrangements. Document E2 was explicitly mentioned as an example of such an arrangement (see document E1, page 1, line 19). It was the only example disclosed in document E1. If a person skilled in the art were to put the teaching of document E1 into practice, they would inevitably have used the arrangement disclosed in document E2 and arrived at an arrangement including all the features of claim 1 of auxiliary request 2. Furthermore, document E1 disclosed that "*the system is designed to be used together with a mold for casting a rotor blade for a wind turbine*" (document E1, page 1, lines 15 and 16) and described "*a system 100 for feeding a composite fluid to a mold 130 in accordance with a first embodiment of the invention. The illustrated mold 130 is designed to cast a composite structure, such as a blade 135 for a wind turbine, by means of a Vacuum Assisted Resin Transfer Molding (VARTM) process*" (see document E1, page 12, lines 26 to 31). Document E1 did not describe the "mold (130)" any further, implying that it was the same mould as disclosed in document E2. Consequently, document E1 did not refer to document E2 as prior art but described an add-on enhancement for the VARTM arrangement disclosed in document E2. The "mold (130)" of document E2 was an essential prerequisite for implementing the teachings of document E1 and therefore had to be considered integral to document E1.

(b) Auxiliary request 2: inventive step of the subject-matter of claims 1 and 8 starting from document E3

(i) Patent proprietor

Document E3 was a suitable starting point for examining inventive step. The subject-matter of claim 1 of auxiliary request 2 differed from the disclosure of document E3 in features c), g), h) and i). The technical effect was improved control of fibre/resin ratios, a reduced risk of formation of wrinkles and air pockets, and the provision of an overall high-quality infusion and composite structure (see patent, paragraph [0016]). The objective technical problem was thus the provision of improved process control leading to an improved infusion process which resulted in composite structures with less defects such as wrinkles.

The subject-matter of claim 1 of auxiliary request 2 involved an inventive step starting from document E3 in view of the common general knowledge as e.g. exemplified in document E5.

The person skilled in the art would not have turned to document E5 since it was not concerned with the objective technical problem. Document E5 was a book on process modelling in composites manufacturing (see document E5, title). It was not a standard textbook from the relevant technical field since it was concerned with computer modelling rather than the blade manufacturing process.

Turning to its content, document E5 did not teach using pressure sensors and thus did not disclose features c), g), h) and i) of claim 1 of auxiliary request 2. Page 426 of document E5 only generally described that

injection equipment should allow changes in injection pressure or flow rate. Moreover, pages 426 to 427 of document E5 referred to RTM systems, not VARTM systems. The latter were referred to in document E5 starting from page 428, third paragraph. The differences between these two systems were explained on pages 416 to 420 of document E5. Even if the distinguishing features were disclosed in document E5, they were disclosed in the context of RTM systems and, due to the differences between RTM and VARTM systems, they were not applicable to VARTM systems. Mould damage and bending caused by the high-pressure injection in RTM was not a concern in VARTM. The "ballooning" of the vacuum bag - as mentioned by the opponent - was not addressed in document E5. Document E5 did not mention an upper pressure threshold, let alone a lower pressure threshold. The opponent's reference to basic feedback loop control arrangements was not disclosed in document E5.

The subject-matter of claim 1 of auxiliary request 2 was also not rendered obvious by the combination of document E3 and document E10I.

Document E10I related to a different objective, namely the benefits and risks of using a meter-mix machine for supplying mixed resin, where some meter-mix machinery delivered pressures too high for an infusion process (see document E10I, fifth paragraph). The person skilled in the art would not have considered document E10I since it did not mention improved control of fibre/resin ratios and the quality of the resulting composite structure.

Even in the unlikely event that the person skilled in the art would have considered document E10I, they would

not have arrived at the subject-matter of claim 1 of auxiliary request 2. The fifth paragraph of document E10I disclosed that the pressure was sensed under the mould film. It did not disclose a pressure sensor at the resin inlet (feature c). Document E10I also did not disclose pressure thresholds (feature i) and did not relate to VARTM systems but used high-pressure resin injection "at up to 8 bar pressure" (see document E10I, fifth paragraph). It was logical that the valve opened and closed, but document E10I did not teach when to open and close the valve.

The opponent's reference to the content of the other disclosures listed under E10 to interpret document E10I amounted to an impermissible aggregation of documents which did not reflect the individual disclosures of these references.

The combination of documents E3 and E11B did not result in the claimed invention according to the subject-matter of claim 1 of auxiliary request 2.

The subject-matter of claim 1 of auxiliary request 2 was inventive over document E3 combined with document E11B.

Document E11B contained slides of a presentation allegedly held in November 2010. It was not apparent which content was made available and whether the conference was publicly accessible. Document E11B, thus, did not form part of the state of the art under Article 54(2) EPC.

Even if the content of document E11B were considered to form part of the prior art, it did not disclose the distinguishing features of claim 1 of auxiliary request

2. Document E11B was silent on pressure thresholds, as such. It did not teach measuring pressure at the resin inlet. The photograph on slide 14 did not contain a clear and unambiguous disclosure in this regard. Slide 15 of document E11B mentioned "in-mould pressure sensing" but not measuring the pressure at the resin inlet. The graph on slide 17 only showed that a y-value was varying between positive and negative values. There was no indication of any units or scale. Thus, no threshold and no feedback loop could be derived. Furthermore, a fixed set point was not the same as an upper and lower threshold.

The subject-matter of claim 1 of auxiliary request 2 also involved an inventive step over the combination of documents E3 and E4.

Document E4 disclosed a system and method for improved infusion of a fibre preform with resin. It did not address the objective technical problem of improved control of fibre/resin ratios. One or more sensors were attached to the mould base portion and/or the mould closure portion for monitoring flow characteristics of the resin within the mould chamber (see document E4, Figure 1; paragraphs [0023], [0040] and [0045]; and claim 3). However, document E4 did not disclose a pressure sensor at the resin inlet. On the contrary, in document E4, sensors were positioned on the mould closure portion and/or the mould base portion (see document E4, paragraph [0039]). In addition, document E4 did not disclose the control of the resin flow rate according to feature i). The target ranges as mentioned in paragraph [0042] of document E4 could be open or closed ranges but did not inevitably imply upper and lower limits for the pressure. Thus, the person skilled in the art would not have arrived at the subject-matter

of claim 1 of auxiliary request 2 by the combination of documents E3 and E4.

Therefore, the subject-matter of claim 1 of auxiliary request 2 involved an inventive step. The same conclusions applied *mutatis mutandis* for the subject-matter of claim 8 of auxiliary request 2.

(ii) Opponent

The subject-matter of claim 1 of auxiliary request 2 was not inventive starting from document E3. The opposition division correctly found that the subject-matter of claim 1 differed from document E3 in features c), g), h) and i) and that the objective technical problem was to improve resin distribution into the fibres (see decision under appeal, Reasons, point 5.3.4.2 and 5.4.3.3).

The person skilled in the art would have arrived at the subject-matter of claim 1 of auxiliary request 2 in an obvious way by the combination of document E3 with the common general knowledge, as exemplified in document E5.

Regarding the common general knowledge, document E5 disclosed the general principles of VARTM and that resin injection pressure and flow rate were key control parameters in VARTM arrangements (see document E5, page 426). According to document E5, most of the injection equipment was designed for either pressure controlled or flow rate controlled injections. Document E5 further disclosed that flow rate controlled injection equipment should allow the user to set an upper critical injection pressure to protect the mould from damage and bending and that once the critical pressure was

reached, the flow rate would be reduced. The latter explicitly corresponded with the requirement in claim 1 of auxiliary request 2 for "*increasing a resin flow rate, if the pressure measured by the pressure sensors at the resin inlet drops below a lower threshold level*". Taken as a whole, document E5 showed that the person skilled in the art was familiar with the use of a control unit to control the resin flow rate into a VARTM mould based on the resin injection pressure, i.e. the resin pressure at the resin inlets. A basic principle of VARTM operations was that atmospheric pressure acting on the exterior of the vacuum bag presses the bag onto the fibre lay-up (see document E5, page 428). This ensured that the fibre layers were not forced apart by resin during infusion, which would reduce the fibre/resin ratio of the final product. If the pressure inside the mould cavity exceeded atmospheric pressure, the vacuum bag began to "balloon". If the resin flow rate was reduced whenever the critical pressure was exceeded, it was common sense that it also had to be increased again since otherwise the operation would fail.

Consequently, features g), h) and i) of claim 1 of auxiliary request 2 were disclosed in document E5.

Concerning feature c) of claim 1 of auxiliary request 2, the person skilled in the art understood how to position pressure sensors in accordance with standard engineering principles. The opposition division's statement (see decision under appeal, Reasons, point 5.3.4.6) that document E5 failed to disclose feature c) was overly simplistic. Document E5 explicitly referred to the injection pressure and as such to the pressure at which the resin was injected, namely at the resin inlet. The highest resin pressure within the mould was

at the resin inlet. For this reason, document E5 focused on the injection pressure.

Consequently, document E5 showed that the person skilled in the art was fully aware of the solution to the above-mentioned objective technical problem and that the person skilled in the art would have attached a pressure sensor to the resin inlet to measure the injection pressure as taught by document E5.

The person skilled in the art would also have arrived at the subject-matter of claim 1 of auxiliary request 2 in an obvious way by the combination of document E3 with document E10I.

Document E10I related to an arrangement in which a meter-mix machine mixed resin on demand and supplied it directly to a mould in a VARTM system. Therefore, the person skilled in the art would have considered its teaching. As the meter-mix machine supplied the resin at an elevated pressure, resin flow through each inlet was regulated by a respective inlet valve operated based on signals from pressure sensors that measured the pressure of the resin as it entered the mould. The fifth paragraph of document E10I disclosed that the system "*provides precision inlet pressure control at the mold face monitored from directly under the film*". Point 5.3.4.11 of the Reasons of the decision under appeal rightly noted that document E10I disclosed control equipment able to control the pressure during injection of resin in a VARTM process. Contrary to the opposition division's conclusion, document E10I provided clear disclosure of feature i). Especially from the text beneath the figure of document E10I, it was clear that the resin flow rate was decreased by closing the valves if the pressure measured by the

pressure sensors at the resin inlet was above an upper pressure threshold, i.e. "as pressure builds to near atmospheric". The person skilled in the art would have understood from the words "until the mold fills" that the valve at some point re-opened and in doing so increased the resin flow rate. This corresponded to feature i) of claim 1 of auxiliary request 2.

Accordingly, document E10I taught the person skilled in the art starting from document E3 and seeking to solve the above mentioned objective technical problem to vary the resin flow rate in accordance with readings taken by pressure sensors to keep the resin pressure within a prescribed range.

Finally, document E10I built on the content of the other disclosures listed under documents E10, in particular E10F, whose disclosure informed how the person skilled in the art interpreted document E10I.

Additionally, the person skilled in the art would have arrived at the subject-matter of claim 1 of auxiliary request 2 in an obvious way by the combination of document E3 with document E11B.

As for document E10I, the opposition division's conclusion that document E11B did not disclose feature i) was not correct. Document E11B was a presentation having the title "Developments in Closed Mould Process Control". It was delivered at the event "Composite Innovation 2010" in Manchester, UK, on 10 November 2010 at 11.30 hrs, which was open to the public as evidenced by documents E11C and E11D.

Slide 14 of document E11B showed a pressure sensor attached to resin feed channels of a VARTM mould

(feature c) as in claim 1 of auxiliary request 2. The sensor arrangement shown in this photograph was identical to that of the patent where feed channels were defined as being part of the resin inlet (see patent, paragraph [0017]).

From the subtitle of this photograph of slide 14 of document E11B "Feed-back from infusion to control injection rate", it was clear for the person skilled in the art that an upper and lower pressure threshold were implemented to avoid ballooning. This was also apparent from the graph on the right side of slide 17 of document E11B where the injection pressure oscillated between an upper and lower value. Since claim 1 of auxiliary request 2 did not require the upper threshold to be different from the lower threshold, control of a fixed set value, namely oscillation around a fixed pressure value, was also covered by claim 1 of auxiliary request 2. Therefore, the subject-matter of claim 1 of auxiliary request 2 was not inventive starting from document E3 in combination with E11B.

A further inventive-step objection was based on the combination of documents E3 and E4.

Figure 1 of document E4 related to a VARTM system in which a mould cavity was defined between a mould base and a mould closure in the form of a vacuum bag. A pre-form was positioned in the mould cavity to be impregnated with resin. Resin entered the mould cavity via supply ports and feed resin channels. Resin was pumped at variable volumetric flow rates. The pumps were controlled by a controller based on signals received from pressure sensors distributed around the cavity. The mould cavity was evacuated by vacuum means via vacuum ports.

Since documents E3 and E4 disclosed an identical mould, including the sensor system, the person skilled in the art would have applied the teaching of document E4 to the method and system of document E3.

Paragraph [0045] of document E4 stated that the sensors were employed to monitor the flow characteristics, and paragraph [0042] of document E4 noted that reference signals were representative of target ranges of flow characteristics including resin pressure. So, document E4 taught that values defining a target range were generated for the resin pressure, these values corresponding to a lower and an upper threshold as defined in feature i). The characteristics of the control according to features h) and i) were disclosed in paragraph [0046] of document E4, which taught that the controller acted to vary the resin flow rate through each resin port in accordance with the sensor measurements to keep the resin pressure within a prescribed range.

Concerning the placement of the sensors, paragraph [0040] of document E4 offered different possibilities. It especially disclosed that "*[t]he actual number and placement of the sensors 82 is a matter of routine design choice for one skilled in the art*". Furthermore, document E4 disclosed computer simulation for optimising the number and location of the sensors 82 (see document E4, paragraphs [0040] and [0053]). The placement of the pressure sensor could not be considered inventive if it was a matter of routine design choice. Similarly, paragraph [0035] of document E4 indicated that "*the number and placement of the inlet ports 44, 44' may be optimized in any particular installation*". Thus, according to document E4, the

resin inlets could be placed anywhere, and the positions of the sensors shown in Figure 1 were purely illustrative. Moreover, no technical effect was associated with the placement of the pressure sensor at the resin inlet in the patent. Overall, document E4 taught to have as many sensors as possible to maximise the quantity of monitoring data available.

It followed that the person skilled in the art applying this teaching to document E3 would have attached at least some of the sensors to the resin inlets. If there was only one sensor, the person skilled in the art would have placed it at the feed channel, which was the critical point under the maximum pressure.

Therefore, starting from document E3, document E4 led the person skilled in the art to the same solution to the above-mentioned objective technical problem as claimed in claim 1 of auxiliary request 2. Therefore, the subject-matter of claim 1 of auxiliary request 2 lacked an inventive step over the combination of documents E3 with E4.

In view of the above, the subject-matter of claim 1 of auxiliary request 2 did not involve an inventive step. The same conclusions applied *mutatis mutandis* for the subject-matter of claim 8 of auxiliary request 2.

Reasons for the Decision

1. Auxiliary request 2: novelty of the subject-matter of claims 1 and 8 vis-à-vis document E1

1.1 It is not contested that the priority for claims 1 and 8 of auxiliary request 2 is validly claimed. Thus, document E1 belongs to the prior art under Article 54(3) EPC and is as such only relevant for novelty.

1.2 It is disputed whether document E1 discloses a vacuum bag.

1.3 The case law of the Boards of Appeal is based on a narrow concept of novelty. A prior-art document prejudices the novelty of claimed subject-matter if the latter is directly and unambiguously derivable from that document including any features implicit to a person skilled in the art. The disclosure must be "beyond doubt - not merely probable". The teaching of a document is not to be interpreted as embracing equivalents not disclosed in that document. This is a matter of obviousness (see Case Law of the Boards of Appeal of the European Patent Office, 10th edition, 2022 (Case Law), I.C.4.1, 4.3 and 4.5).

1.4 It is undisputed that document E1 discloses a VARTM process (see document E1, page 12, lines 26 to 31 and Figure 1) without explicitly mentioning the use of a vacuum bag.

1.5 It is contested whether this disclosure of a VARTM process in document E1 necessarily requires the

presence of a vacuum bag. The parties especially discussed the disclosure of documents E1 (see document E1, page 3, lines 13 to 26), E2 (see document E2, page 1, third and fourth paragraph), E5 (see document E5, page 418), E8 (see document E8, paragraph [0021]), E9 (see document E9, page 4, lines 24 to 25) and D12 (see document D12, page 8, second paragraph). The board observes the following.

At least documents E2, E5 and E8 indeed disclose a VARTM process using a vacuum bag. However, these documents do not imply that the VARTM process of document E1 implicitly includes the use of a vacuum bag. Document E1 itself discloses (see document E1, page 3, lines 13 to 26) "*[s]uch a mold [...] in its closed state where e.g. upper and lower mold halves are tightly connected to each other, be substantially cylindrical and may have a length of up to about 60 m or more, depending on the length of the blade to be casted, and a height of up to about 3 m or more, depending on the cross-sectional size of the blade to be casted*". This passage of document E1 discloses a sealed matched tool as the upper and lower mould halves are to be tightly connected to each other and are cylindrical. There is no reference to a vacuum bag. The opponent's argument that this passage referred to a special "one shot" process for manufacturing wind turbine blades, as disclosed in document E14, which discloses an internal vacuum bag, is not convincing since there is no reference to document E14 in this context. Moreover, a core does not inevitably consist of an inner vacuum bag. Furthermore, the opposition division's argument (see decision under appeal, Reasons, point 4.2.2) that this passage refers to two moulds, each capable of producing a shell for the blade, is not supported by any indication in document

E1.

1.6 According to the board, document D12 provides additional support for determining whether the vacuum bag is an implicit feature of the VARTM process described in document E1. Document D12 is a handbook published 1.5 years after the priority date of the patent. On page 8 of document D12, a general explanation for a VARTM process is given. It reads:

"*Vacuum assisted RTM (VARTM). A manufacturing route typically used for smaller volumes or very large parts (e.g. wind turbine blades and boat hulls) that combines the simplicity of hand lay-up techniques with the achievable part quality towards that of RTM. Fibre preforms are laid dry into a single-sided tool with an upper vacuum bag, or a sealed matched tool, and resin is then introduced under vacuum. Maximum fibre v.f. 55-60%.*"

The opponent's contention that document D12 is a handbook from an unrelated area, namely "Management, recycling and reuse of waste composites", is not compelling as the above-mentioned passage clearly discusses the fabrication of wind turbine blades.

A further argument by the opponent with reference to decision T 1110/03 was that document D12 did not reflect the skilled person's common general knowledge and understanding of the VARTM method at the priority date of the patent. The board acknowledges that document D12 is not itself part of the state of the art but rather serves as indirect evidence of the use of a sealed matched tool as a possible alternative to a vacuum bag in a VARTM manufacturing process for wind turbine blades. Considering the very basic nature of

this information, the board has no doubt that this was known prior to the priority date of the patent. Document D12 confirms the view that the VARTM process for wind turbine blades disclosed in document E1 does not necessarily require the use of a vacuum bag (see above).

1.7 Document E1 cites document E2, which specifically refers to a VARTM technique utilising a vacuum bag. Nonetheless, the parties are at odds regarding whether document E2 constitutes part of the disclosure of document E1.

In the context of novelty, it is a generally accepted principle that it is not permissible to combine separate items of prior art (see Case Law, I.C.4.2). The board concurs with the opinion of the opposition division (see decision under appeal, Reasons, point 4.1.2) that the disclosure of document E2 cannot be considered part of the disclosure of document E1.

Document E2 is solely referenced in the background section of document E1 and merely serves as one example of a VARTM process. Document E1 discloses that:

"*[r]einforced composite structures, such as rotor blades for wind turbines, can be produced by means of a process known as VARTM (Vacuum Assisted Resin Transfer Molding). In such a process, which is e.g. described in WO 2009/103736 A2 (*note: document E2*), resin and hardener is mixed in a mixer which in turn supplies the mixed resin to the mold.*"

There is no further reference to the VARTM system of document E2 in either the summary of the invention or the detailed description of document E1. Document E1

discloses a VARTM system in the context of Figure 1 (see document E1, page 12, lines 26 to 36) which, however, does not directly and unambiguously disclose a vacuum bag. Since there is no specific reference in document E1 to the set-up of document E2, decision T 153/85 cited by the opponent is not applicable to the case at hand (see decision T 153/85, Reasons, point 4.2).

The opponent's argument that there was only one example for a VARTM process in document E1 and that document E2 was this example is not convincing. Precisely because document E2 is cited only as an example, other possibilities are not excluded, and the features of the mould of document E2 cannot be read into the disclosure of document E1.

There is no specific reference suggesting that the vacuum bag disclosed in document E2 is used in the process of document E1.

1.8 Conclusion on novelty of the subject-matter of claims 1 and 8 of auxiliary request 2

Document E1 neither explicitly nor implicitly discloses that a vacuum bag is arranged on top of the rigid mould part. The subject-matter of claim 1 of auxiliary request 2 therefore differs from document E1 in feature d) "arranging a vacuum bag (43) on top of the rigid mould part (13) and sealing the vacuum bag (43) to the mould part (13) to define the mould cavity", and the subject-matter of claim 8 of auxiliary request 2 differs from document E1 in "a vacuum bag (43) for sealing against the rigid mould part (13) so as to form a mould cavity".

The subject-matter of claims 1 and 8 of auxiliary request 2 is new over document E1 (Article 54(1) and (3) EPC).

2. Inventive step of the subject-matter of claims 1 and 8 of auxiliary request 2

2.1 The opponent raised inventive-step objections against the subject-matter of claim 1 of auxiliary request 2 starting from document E3 in combination with the common general knowledge as reflected in document E5 or in combination with any of documents E10I, E11B and E4.

2.2 There is consensus that document E3 is a suitable starting point for the assessment of inventive step and that the distinguishing features are features c), g), h) and i) of claim 1 and the corresponding features of claim 8 of auxiliary request 2.

2.3 According to the decision under appeal (see decision under appeal, Reasons, point 5.3.4.3) and as agreed by the opponent, the technical effect of these distinguishing features is improved control of resin flow into the mould cavity (see patent, paragraph [0016]). The objective technical problem can be formulated as the provision of improved resin distribution into the fibres.

The patent proprietor specified the technical effect as improved control of fibre/resin ratios, a reduced risk of formation of wrinkles and air pockets, and the provision of an overall high-quality infusion and composite structure (see patent, paragraph [0016]). This resulted in an objective technical problem of providing improved process control leading to an improved infusion process which resulted in composite

structures with less defects such as wrinkles.

The board is of the opinion that the general formulation of the objective technical problem used by the opposition division, namely improved resin distribution into the fibres, subsumes these effects mentioned by the patent proprietor. The board therefore adheres to the objective technical problem as defined by the opposition division.

2.4 Obviousness in view of the combination of document E3 with the common general knowledge (document E5)

2.4.1 Document E5 is an excerpt from the book "Process Modeling in Composites Manufacturing". The opponent refers to pages 426 and 427, which deal with "Injection and Resin Delivery System", especially in the context of RTM. Vacuum infusion processes are mentioned on page 428:

"*For vacuum infusion processes, a vacuum pump is used that serves multiple purposes. It (i) draws the resin into the mold from a reservoir that is at room temperature and pressure, (ii) provides a good mold seal to draw most of the air out and (iii) compacts the preform in the mold as one of the surfaces is a flexible bag with vacuum pressure on the inside and atmospheric pressure on the outside. The resin in this process is usually introduced through an omega tube at one end and is vented at the other end as shown in Figure 8.24. As only one atmosphere is available, the resin flow is very slow and any mechanism to speed up the flow is highly desirable especially if one is interested in making large scale parts such as the wind blades or aerospace fuselages.*"

2.4.2 The board agrees with the opponent that this book belongs to the common general knowledge of the person skilled in the art. The patent proprietor's argument that document E5 concerns the mathematical simulation of current manufacturing techniques does not oppose this conclusion.

2.4.3 However, in the board's opinion and as brought forward by the patent proprietor, the passage on page 428 of document E5 which deals with vacuum infusion processes does not disclose anything about pressure sensors and pressure control according to features c), g), h) and i) of claim 1 of auxiliary request 2.

Pages 426 to 427 of document E5, which were referred to by the opponent, are concerned with injection pressure controlled equipment. The opponent understands the term "injection pressure" as referring to the pressure at the resin inlet. However, according to the board's opinion, the term "injection pressure" does not necessarily imply that a pressure sensor is located where the resin is injected into the mould. The pressure might also be measured upstream of the resin inlet.

Furthermore, the passage on pages 426 to 427 of document E5 cited by the opponent pertains to RTM systems, the teaching of which cannot be directly applied to VARTM systems. In VARTM systems, resin is not delivered under (positive) pressure but rather through vacuum infusion. For this reason, the passage on page 426 discloses an upper critical pressure to protect the mould from damage and bending but remains silent on ballooning, which can occur with positive pressures in VARTM processes.

2.4.4 In view of the above, document E5 cannot prove that it belonged to the skilled person's common general knowledge to attach one or more pressure sensors to the resin inlet for monitoring the pressure in a VARTM process and for controlling the resin flow rate supplied to the resin inlets in view of lower and upper pressure threshold levels.

2.4.5 Consequently, the subject-matter of claim 1 of auxiliary request 2 is not obvious in view of a combination of document E3 with the common general knowledge (document E5).

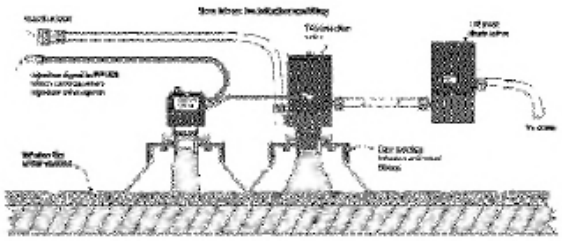
2.5 Obviousness in view of the combination of documents E3 and E10I

2.5.1 Document E10I is an extract from an online article "A better way to infusion mold blades" dated 8 June 2010. Document E10I', which is a screenshot of a Wayback Machine capture of E10I, was submitted to demonstrate the publication date of this article.

2.5.2 Regarding the series of documents E10 concerned with the Turbo Auto Sprue injection valve, the board points out that these documents do not form one single disclosure and that it is not proven that all of them disclose the same valve. Moreover, document E10B does not contain any reference to any of these other documents. The fact that the submitted publications of the E10 series all relate to the company Magnum Venus Plastech does not, as such, affect their technical teaching and cannot alter this conclusion. Therefore, the disclosure of the other documents of the series cannot be integrated into or employed to interpret document E10I.

2.5.3 Document E10I is concerned with infusion moulding of large composite structures such as turbine blades. Fibre plies are laid in a mould, subjected to a vacuum and infused with catalysed resin (see document E10I, first paragraph). Document E10I especially relates to the supply of mixed resin. Since it does not address resin distribution within the mould, the person skilled in the art would not have consulted document E10I.

2.5.4 Even if they had, document E10I does not disclose a lower threshold. It solely mentions an upper threshold.



A basic three-inlet infusion resin mold shows its simplicity over other schemes. In operation, resin is fed to each inlet Turbo Auto Sprue valve. The pressure sensed under the mold film lets controls open or close the valves. As pressure builds to near atmospheric, the valve closes until the mold fills. The set up repeats for many infusion points on the structure all fed from one machine and all cleaned the same way leaving no disposable pipes or resin containers.

The text below the above reproduced figure discloses an upper threshold, namely: "*As pressure builds to near atmospheric, the valve closes until the mold fills*". It is apparent that the valve re-opens at a certain point, but the moment when this happens is not specified. In particular, it is not disclosed that the valve re-opens if the pressure measured by the pressure sensors at the resin inlet drops below a lower threshold (feature i)).

Moreover, document E10I does not disclose a pressure

sensor at the resin inlet but at the mould face.

2.5.5 Thus, the combination of documents E3 and E10I would not have rendered obvious the subject-matter of claim 1 of auxiliary request 2.

2.6 Obviousness in view of the combination of documents E3 and E11B

2.6.1 Regarding the technical disclosure of document E11B, the board agrees with the opponent that slide 14 shows an arrangement apparently corresponding to that of the patent, where the pressure sensor is arranged in the resin channel. According to paragraph [0017] of the patent, "*the resin inlet may comprise a resin inlet channel or feed channel and optionally an inlet box or port*". Thus, feature c) is anticipated by document E11B. Features g) and h) are also disclosed (see document E11B, slides 14 and 16, subtitle "Feed-back from infusion to control injection rate").

2.6.2 However, document E11B does not explicitly disclose any details on the pressure control. The graph on slide 17 of document E11B, which the opponent refers to, does not specify the scale of the y-axis. It only discloses that the value for the injection pressure oscillates around zero. It is not possible to deduce the presence of an upper and lower pressure threshold according to feature i) of claim 1 of auxiliary request 2 from this. The opponent's argument that the upper and lower thresholds might be equal and that there was an oscillation about a fixed single pressure value is not convincing since it is not based on how the skilled person would understand the terms of an upper and lower pressure threshold in the context of feature i). Moreover, there is no basis for such an interpretation

in the patent. Consequently, document E11B does not disclose feature i).

2.6.3 Since the combination of documents E3 and E11B does not disclose feature i) of claim 1 and the corresponding feature of claim 8 of auxiliary request 2, the subject-matter of claim 1 of auxiliary request 2 is not obvious in view of the combination of document E3 with document E11B. Thus, the question of whether the content of document E11B was made available to the public before the priority date of the patent may be left open.

2.7 Obviousness in view of the combination of documents E3 and E4

2.7.1 Document E4 is concerned with improved infusion in VARTM processes (see document E4, paragraphs [0001] and [0004]). Therefore, the board is of the opinion that the person skilled in the art would have considered document E4 when looking for improved control of resin flow into the mould cavity.

2.7.2 The patent proprietor acknowledges that features g) and h) are anticipated by document E4 (see document E4, Figure 1 and paragraphs [0045] and [0046]). However, it is disputed whether document E4 discloses features c) and i).

2.7.3 While the board is of the opinion that the target ranges disclosed in paragraph [0042] of document E4 could correspond to the upper and lower thresholds according to feature i), feature c) of claim 1 of auxiliary request 2 is not disclosed.

For feature c), the opponent cited paragraphs [0035], [0040] and [0053] of document E4 and argued that the

attachment of one or more pressure sensors at the at least one resin inlet belonged to the common general knowledge. The board notes that although document E4 teaches to use several sensors, these sensors are positioned on the mould closure portion and/or the mould base portion (see document E4, paragraph [0040]). Document E4 does not suggest a pressure sensor at the resin inlet. Furthermore, the board points out that in document E4 the resin inlet is not arranged above the fibre lay-up. Therefore, in document E4 the person skilled in the art would not have found any incentive to attach the pressure sensor to the resin inlet.

The opponent's argument that the location of the pressure sensor is not related to any technical effect is less relevant for whether the person skilled in the art gets any prompt or guidance from document E4 to place the pressure sensor at the resin inlet according to feature c) of claim 1 of auxiliary request 2.

2.7.4 Therefore, by combining documents E3 and E4, the person skilled in the art would not have arrived in an obvious way at the solution as claimed in claim 1 of auxiliary request 2.

2.8 Conclusion on inventive step of the subject-matter of claims 1 and 8 of auxiliary request 2

The subject-matter of claim 1 of auxiliary request 2 is not rendered obvious starting from document E3 in combination with the common general knowledge as reflected in document E5 or in combination with any of the documents E10I, E11B and E4 (Article 56 EPC). The same conclusion applies *mutatis mutandis* for the subject-matter of claim 8 of auxiliary request 2.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the opposition division with the order to maintain the patent as amended on the basis of claims 1 to 15 according to auxiliary request 2 as filed with appellant II's statement of grounds of appeal and after any necessary consequential amendment of the description.

The Registrar: The Chairman:

N. Schneider P. Lanz

Decision electronically authenticated