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Datasheet for the decision of 29 October 2013

Case Number: T 1347/11 - 3.3.09

Application Number: 04721755.9

Publication Number: 1606339

IPC: C08J5/18, C09D105/14, C08L5/14

Language of the proceedings: EN

Title of invention:
POLYMERIC FILM OR COATING COMPRISING HEMICELLULOSE

Patent Proprietor:
Xylophane AB

Opponents:
Valea AB
BillerudKorsnäs AB
ZACCO SWEDEN AB

Headword:

Relevant legal provisions:
EPC Art. 100(b), 111(1)

Keyword:
Grounds for opposition - sufficiency of disclosure (yes)
Remittal to the department of first instance - (yes)

Decisions cited:
T 0051/87, T 1437/07

Catchword:

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Case Number: T 1347/11 - 3.3.09

D E C I S I O N
of Technical Board of Appeal 3.3.09
of 29 October 2013

Appellant: (Patent Proprietor)	Xylophane AB Färjevägen 1 445 80 Bohus (SE)
Representative:	HOFFMANN EITLE Patent- und Rechtsanwälte Arabellastrasse 4 81925 München (DE)
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Respondent: (Opponent 3)	ZACCO SWEDEN AB P.O. Box 23101 104 35 Stockholm (SE)
Representative:	Nikolopoulou, Sofia Zacco Sweden AB P.O. Box 5581 114 85 Stockholm (SE)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted on 30 March 2011 revoking European patent No. 1606339 pursuant to Article 101(3)(b) EPC.**

Composition of the Board:

Chairman:	W. Sieber
Members:	N. Perakis
	F. Blumer

Summary of Facts and Submissions

I. Mention of the grant of European patent No. 1 606 339 in the name of Xylophane AB, was published on 23 July 2008 (Bulletin 2008/30). The patent was granted with 21 claims, claim 1 reading as follows:

"1. A polymeric film or coating comprising hemicellulose having a molecular weight of less than 50 000 g/mol, and at least one component selected from the group consisting of plasticizers, cellulose and an oligomer or polymer."

II. Notices of opposition were filed by:

- Valea AB (opponent 1)
- Billerud AB, now BillerudKorsnäs AB (opponent 2), and
- Zacco Sweden AB(opponent 3),

all requesting revocation of the patent in its entirety for lack of novelty and lack of inventive step (Article 100(a) EPC) and for insufficiency of disclosure (Article 100(b) EPC).

The following documents *inter alia* were cited by the parties during the proceedings:

D1: M. Gröndahl, "Effect of Molecular Architecture of Xylan on Material Properties", Thesis for the Degree of Licentiate of Engineering, Department of Materials and Surface Chemistry, Chalmers University of Technology, Göteborg Sweden 2003, including papers I, II and III;

D4: C. Péroval *et al*, "Edible Arabinoxylan-Based Films", *J. Agric. Food Chem.*, 2002, 50, pp 3977-3983;

D7: I. Gabrielii *et al*, "Separation, characterization and hydrogel-formation of hemicellulose from aspen wood", *Carbohydrate Polymers*, 2000, 43, pp 367-374;

D8: M. Gustavsson *et al*, "Isolation, Characterisation and Material Properties of 4-O-Methylglucuronoxylan from Aspen", in Biorelated Polymers: Sustainable Polymer Science and Technology, edited by Chiellini *et al*, Kluwer Academic/Plenum Publishers 2001, pp 41-52;

D12: EP 0 400 484 A1;

D13: A. Jacobs *et al*, "Characterization of the Molar Masses of Hemicelluloses from Wood and Pulps Employing Size Exclusion Chromatography and Matrix-Assisted Laser Desorption Ionization Time-of-Flight Mass Spectrometry", *Biomacromolecules*, 2001, 2(3), pp 894-905;

D16a: D.V. Rosato *et al*, Injection Molding Handbook, 3rd edition, Kluwer Academic Publishers, 2000, pp 1038-1041;

D17a: G. Odian, "Principles of Polymerization", 2nd edition, John Wiley & Sons Inc, 1981, pp 20-25;

D18: B. Saake *et al*, "Isolation and Characterization of Arabinoxylans from Oat Spelts", ACS Symposium Series 864, Hemicelluloses: Science and

Technology, edited by P. Gatenholm and M. Tenkanen, 2004, pp 52-65;

D19: B. Saake *et al*, "Investigation on molar mass, solubility and enzymatic fragmentation of xylans by multi-detected SEC chromatography", *Bioresource Technology*, 2001, 80, pp 195-204;

D20: J.M. Fang *et al*, "Comparative study of hemicelluloses from wheat straw by alkali and hydrogen peroxide extractions", *Polymer Degradation and Stability*, 1999, 66, pp 423-432;

D21: R.C. Sun *et al*, "Comparative study of hemicelluloses from rice straw by alkali and hydrogen peroxide treatments", *Carbohydrate Polymers*, 2000, 42, pp 111-122;

D22: J.H. Prescott *et al*, "New molecular weight forms of arabinogalactan from *Larix occidentalis*", *Carbohydrate Research*, 1997, 301, pp 89-93;

D25: Expert opinion entitled "Some standpoints concerning the answer from Xylophane AB [the Patentee] concerning objections to EP 160633" signed by Dr Peter Axegård, Innventia AB, dated 15 November 2010;

D27: W.W Yau *et al*, "Modern Size-Exclusion Liquid Chromatography: Practice of Gel Permeation and Gel Filtration Chromatography", Wiley-Interscience publication, 1979, pp 315-341;

D32: Experimental evidence conducted by opponent 3 and filed with letter dated 8 December 2010; and

D34: T 559 pm-96, "Grease resistance test for paper and paperboard", 1996, TAPPI (also including an excerpt from Tappi's website re to this test).

The patent proprietor filed the following technical evidence:

E1: Experimental evidence for the effect of (i) the molecular weight of the hemicellulose and (ii) the thickness of the film on the mechanical properties of the film, as described in the letter of 8 December 2009 (see point 5.2 on pages 10-12);

E2: Interpretation of the experimental results of E1 relating to testing the coating integrity by means of the "TAPPI 559 method", submitted in the letter of 4 February 2011 (see point 2.3 on pages 7-9);

and

D36: Experimental evidence entitled "The experimental report on the free 10 µm film", with letter of 4 February 2011.

III. By a decision announced orally on 8 February 2011 and issued in writing on 30 March 2011 the opposition division revoked the patent because the invention as claimed in all requests, namely the main request and auxiliary requests 1 to 3, did not disclose the invention in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art.

Only the main request is relevant to the present decision, with claim 1 reading as follows:

"1. A polymeric film or coating having a thickness of 10 µm or less, comprising hemicellulose having a molecular weight from 20 000 to less than 50 000 g/mol, and at least one component selected from the group consisting of plasticizers, cellulose and an oligomer or polymer."

As regards the main request, the opposition division decided that:

- the contested patent did not enjoy the claimed priority date so that the effective date was the filing date, namely 18 March 2004;
- the claims fulfilled the requirements of Articles 123(2) and 123(3) EPC;
- the claims also fulfilled the requirements of Article 84 EPC;
- however, the skilled person, based on the information provided in the patent in suit and his common general knowledge, would not be able to reproduce the invention of claim 1 over its entire scope without undue burden.

As regards sufficiency of disclosure, the opposition division objected to:

- The absence of a clear and complete disclosure regarding the sources of the hemicellulose to be used in claim 1, because hemicellulose extracts with the same molecular weight may have different structures or different monomer compositions, which would lead to substantial differences in the film-forming properties.

- The absence of a clear and complete disclosure regarding the method of extraction of the

hemicellulose to be used in claim 1 since, depending on the extraction conditions, the molecular weight of the hemicelluloses varies dramatically.

- The lack of disclosure regarding the specific molecular weight of the hemicellulose, i.e. whether it is a molecular weight distribution that is claimed (MWD) or a specific type of average molecular weight such as M_w, M_n or M_v, and the applicable method of determination, since different methods provide different results.

- The absence of the conditions under which a hemicellulose with a molecular weight of from 20 000 to less than 50 000 g/mol and mixed with at least one component selected from the group consisting of plasticisers, cellulose and an oligomer or polymer is processed and provides a film or coating with a thickness of 10 µm or less.

IV. On 31 May 2011 the patent proprietor (hereinafter the appellant) filed an appeal against the decision of the opposition division and paid the appeal fee on the same day. The statement setting out the grounds of appeal was filed on 5 August 2011. The appellant requested that the board reverse the decision of the opposition division and acknowledge sufficiency of disclosure on the basis of the main request or auxiliary requests 1 to 3 (all requests filed before the opposition division) or auxiliary requests 4 to 7.

The appellant also filed the following additional documents:

D37: Expert opinion of Prof. Dr. Claus D. Eisenbach dated 22 June 2011;

D38: M. Tombs and S.E. Harding, "An Introduction to Polysaccharide Biotechnology", Taylor & Francis, 1998, pp 9-10;

D39: Experimental report entitled "Films and Coatings of Arabinoxylan (Mw: 15500 and 21000)" signed by M. Gröndahl and M. Palmlöf;

D40: Experimental report entitled "Experimental data relating to D32 and D36, Free-standing 10 µm films and coatings on PET substrates" signed by M Gröndahl and M. Palmlöf; and

D41: Experimental report entitled "Experimental data on 10 µm hemicellulose films and coatings" signed by M. Gröndahl and M. Palmlöf.

V. By letter of 9 November 2012 the appellant filed additional technical evidence E3 supplementing experimental reports D39 and D41, and concerning:

- Size exclusion chromatography (SEC) measurement of the samples used in D39 using the solvent and conditions as specified in the opposed patent (see page 4); and

- the determination of the oxygen permeability of the samples of D41 (see page 7).

VI. Opponent 1 (thereafter respondent 1) did not submit any observations on the appeal. By letter of 23 April 2013 it merely announced that it did not intend to attend the oral proceedings before the board.

VII. Opponent 2 (thereafter respondent 2) filed observations on the appeal by letter of 12 December 2011, including the following additional document:

D45: L.K. Kostanski *et al*, "Size-exclusion chromatography - a review of calibration methodologies", *J Biochem Biophys Methods*, 2004, 58, pp 159-186.

By letter of 2 October 2013 respondent 2 filed additional observations.

VIII. Opponent 3 (thereafter respondent 3) filed observations on the appeal by letter of 12 December 2011, including the following additional documents:

D42: A. Höije *et al*, "Isolation and characterization of physicochemical and material properties of arabinoxylans from barley husks", *Carbohydrate Polymers*, 2005, 61, pp 266-275;

D43: M.P. Stevens, POLYMER CHEMISTRY An Introduction, Oxford University Press, 2nd edition, 1990, pp 40-67; and

D44: Shodex® Brochure, Calibration Standards for Aqueous SEC (GFC) http://www.sodex.com/english/da0905.html of 6 December 2011.

IX. Oral proceedings were held before the board on 29 October 2013 in the absence of respondent 1.

X. The relevant arguments put forward by the appellant in its written submissions and during the oral proceedings may be summarised as follows:

- The molecular weight in the patent would be understood by the skilled person in the technical field of hemicellulose to be the average molecular weight and not the molecular weight distribution. The skilled person was aware that hemicellulose naturally occurred as a polydisperse polymer having a certain average molecular weight and would therefore interpret the molecular weight of claim 1 as an average molecular weight.

- The molecular weight limits in claim 1 could only apply to a weight average molecular weight, since the weight average molecular weight was the type of molecular weight usually specified in the context of hemicellulose and the most relevant in view of viscosity. This was clear from the opposed patent, which taught that the molecular weight was important in view of viscosity and film-forming properties and specifically addressed the favourable mechanical properties of the films and coatings. Anyway, the skilled person was aware that these properties were primarily determined by the weight average molecular weight, and since the weight average molecular weight was the commonly cited molecular weight value in the prior art, specifically in connection with film properties, the skilled person would interpret the indications in the patent in suit as referring to the weight average molecular weight.

- The patent in suit disclosed the method for the measurement of the weight average molecular

weight. The universal calibration using viscosity and RI data and pullulan standards was a well-known technique (see D19) relying on the calculation of the intrinsic viscosity and provided molecular mass data independent from the standard. The software used for the evaluation of the data eliminated the measurement error source. In addition, parameters determined by a measurement procedure were always subject to a certain measurement error, hence the skilled person would interpret the disclosed values accordingly.

- The interpretation of the molecular weight on the basis of D5, whose universal calibration yielded M_n rather than M_w, was not correct. D45 did not refer to universal calibration in general but concerned the specific case of complex polymers. In that specific case the M_n could be calculated exactly while for the calculation of the exact weight average molecular weight further information as to the polydispersity of each polymer fraction (i.e. a SEC-fraction at a specific elution volume which consisted of polymer chains of the same hydrodynamic volume but different molecular weight) would be required. However, it was possible to calculate an apparent weight average molecular weight by ignoring the fact that the SEC-fraction at a given elution volume might be polydisperse. This was done in the prior art (D19). Thus no matter whether such M_w was exact or merely apparent, it was possible and usual to determine such M_w and the disclosure of the patent in suit would be interpreted accordingly.

- Concerning the experimental results in D39-D41, they demonstrated that for various types of hemicellulose, coatings and films with favourable mechanical properties and barrier properties could be prepared.

- Concerning the preparation of the hemicellulose to be used in the claimed invention, neither its origin nor its extraction process nor even its enzymatic degradation treatment were necessary features. The respondents did not file any evidence that a specific type of hemicellulose did not result in film/coating formation.

- The SEC (Size Exclusion Chromatography) measurement for the determination of the molecular weight determination of a polymer, specifically a hemicellulose, was a well-established technique in the field of polymer chemistry and the capabilities and performance of that technique were also known to the skilled person. He would therefore know how to conduct a SEC measurement as described in the patent in order to determine whether the hemicellulose had the required molecular weight.

- Regarding the film and coating preparation, the differences between the procedures described in the opposed patent and D39-D41 with respect to the process details (temperature and stirring time; substrate for the coating; drying conditions) were marginal. It was neither apparent nor substantiated by the respondents in which way they could have a technical impact, let alone be relevant for the evaluation of sufficiency.

- Regarding experimental report D32 of respondent 3, which did not provide a free-standing film when using the hemicellulose "glucomannan", the only comment the appellant could make was that the experimental report D41 showed that a free-standing glucomannan film according to the invention was obtained.

- Regarding the evidence of D42, which disclosed some films without the expected mechanical properties, this was a post-published document of the present inventors. D42 disclosed hemicellulose materials AX1 to AX4 having molecular weights within the claimed range. However, the films from AX1 and AX4 contained substantial amounts of proteins and lignin, which explained why these films were intransparent and brittle. The skilled person was aware that such particulate contaminants would impair the properties of the film and might cause holes. Accordingly he would understood that for preparing a film, the hemicellulose should be sufficiently pure from particulate contaminants. The films from AX2 and AX3, which had good properties, contained mainly the hemicellulose in combination with glucose (acting as a plasticiser) the amounts of other components being very low.

XI. The relevant arguments put forward by respondents 2 and 3 in their written submissions and during the oral proceedings may be summarised as follows:

- The skilled person would not find in the patent in suit any information that the molecular weight of the hemicellulose in claim 1 should be interpreted to mean the average molecular weight.

- Furthermore, the assertion that it was obvious that the molecular weight in question was the weight average molecular weight (M_w) was incorrect. According to D37, the experimental protocol given in the patent could be used to determine several different types of molecular weight averages. The disclosure in the patent(paragraph [0048]) of the use of pullulan standards in universal calibration analysis based on SEC (Size Exclusion Chromatography), RI-signals and viscosity implied that the M_n of complex polymers such as those of the hemicelluloses was measured rather than the M_w. This was also disclosed in D45 (pages 162, 176 and 177).

- Furthermore, the skilled person would not interpret the term "molecular weight" to mean M_w rather than M_n in view of criticality of viscosity for the film/coating formation and the contribution of M_w to the viscosity control of the hemicellulose (see D17). If the skilled person acknowledged the critical role of the viscosity, he would rather consider the viscosity average molecular weight M_v, which takes into account the molecule's intrinsic viscosity.

- Regarding the method for the molecular weight determination, it was not clear which method the skilled person should use to carry out the invention as the appellant disclosed one method in the patent (paragraph [0048]) and another in the experimental reports: D39 to D41 use a different mobile phase. However, the molecular weight of a certain type of hemicellulose depended on the

method of measurement - in the particular case of SEC on the nature of the mobile phase. This was shown by D19, which compared two different SEC systems and identified a M_w difference of 17%. In view of this difference, the results of D39-D41 would be outside the claimed range if the mobile phase of the patent in suit was used.

- Regarding the hemicellulose, the patent in suit did not provide any guidance to the skilled person whether to select a hemicellulose molecule which had a molecular weight within the claimed range in its "plain" state or in its final, derivatised, state. Moreover, it was not clear whether the molecule mixture resulting from the enzymatic degradation of the hemicellulose "arabinoxylan" extracted from barley husks in the appellant's experimental report D39 was still a hemicellulose and not something else. The same applied to the molecule mixture in the experimental report D41, which resulted from the acidic hydrolysis of the hemicellulose "konjak glucomannan".

- The hemicellulose of claim 1 was most logically a hemicellulose substituted and/or derivatised during the process of making the film coating. However, neither the patent in suit nor any of the cited prior art documents provided any information about how to measure the molecular weight of the hemicellulose present in the film or coating.

- Regarding the film preparation, the appellant argued that the failure in D32 to prepare a free-standing film using a hemicellulose having a M_w within the claimed range was presumably due to the non-removal of insoluble matter before film

formation. The free-standing films of D41 were prepared after insoluble matter had been removed. However, neither insoluble matter nor the removal thereof was discussed in the patent in suit. Consequently, the disclosure was insufficient in that regard.

- Regarding the technical evidence submitted by the appellant in order to prove that it was possible to prepare hemicellulose-containing films or coatings, the protocols applied were not derivable from the application as filed and were not adapted using only common general knowledge. There was no disclosure of a step for the removal of insoluble matter. There was no reason that the skilled person would use the rather complex protocols of D39-D41 to prepare hemicellulose within the claimed M_w range. The five-step extraction method appeared to be the result of a careful optimisation carried out after the filing date of the patent in suit. This also appeared to be the case for the enzymatic and acidic degradation methods used to reach the claimed range.

- The patent in suit did not contain a single example regarding the preparation of a film or coating falling within the scope of claim 1. The later experimental reports related to variants of the protocol of the patent. Thus, the appellant, who bore the burden of proof, did not show that the skilled person, at the filing date, could carry out the invention using only the teaching of the patent and common general knowledge.

- Regarding the common general knowledge, the appellant had referred to various journal articles

(see D13, D19, D21 and D27). However, it had failed to establish that such a selection of a few journals articles represented the common general knowledge of the skilled person at the filing date. Alternative reading of these documents (see D19) and the disclosure of other prior art documents (see D45) showed that the appellant's understanding of the common general knowledge was one-sided and misleading.

- Finally, the patent in suit did not contain sufficient information that would enable the skilled person to carry out the invention over the entire scope as defined in the main request. In the absence of any guidance as to how to obtain a flexible, transparent film or coating with good oxygen properties from any hemicellulose in any amount based only on the information that its molecular weight should be within the numerical range given in the claims, the skilled person would be obliged to conduct several different experiments in order to verify, whether he had obtained the right hemicellulose or not. This amounted to an undue burden.

XII. The appellant (patent proprietor) requested that the decision under appeal be set aside and that the case be remitted to the opposition division for further examination on the basis of claims 1-14 as filed with the letter dated 8 December 2009 (main request), or, alternatively, on the basis of any of the auxiliary requests 1-3 as filed with the letter dated 4 February 2011 or any of the auxiliary requests 4-7 as filed with the statement setting out the grounds of appeal dated 5 August 2011.

XIII. Respondents 2 and 3 (opponents 2 and 3) requested that the appeal be dismissed, or, should the decision under appeal be set aside, that the case be remitted to the opposition division for the examination of novelty and inventive step.

XIV. Respondent 1 (opponent 1) did not file any requests in the appeal proceedings.

Reasons for the Decision

1. The appeal is admissible.

2. Sufficiency of disclosure is the only issue assessed in this decision.

The invention as defined in claim 1 of the main request (see above point III) concerns:

- a polymeric film or coating
- with a thickness of 10 µm or less
- comprising hemicellulose having a molecular weight from 20 000 to less than 50 000 g/mol, and
- at least one component selected from the group consisting of plasticisers, cellulose and an oligomer or polymer.

In view of the objections raised by the respondents, the assessment of sufficiency essentially boils down to the following questions:

Question 1:

What does the skilled person understand by the expression "a hemicellulose having a molecular weight from 20 000 to less than 50 000 g/mol", and where is he supposed to find the disclosure enabling him to reproduce such a hemicellulose?

Question 2:

Which disclosure enables the skilled person to manufacture a polymeric film or coating with a thickness of 10 µm or less?

Question 3:

Where is the disclosure that enables the skilled person to reproduce the invention within the whole claimed range?

3. In order to reply to these questions, it must first be decided what is the filing date of the patent in suit in order to consider the general background knowledge of the skilled person at the filing date. The board refers to the appealed decision (page 21), according to which the patent in suit is not entitled to the alleged priority date of 21 March 2003. The appellant did not raise any objection in this respect. The board in agreement with the opposition division considers that the effective date of the patent in suit is the filing date of 18 March 2004.

4. Next, it is important to define what belongs to the common general knowledge of the skilled person on the filing date of the patent in suit.

In the circumstances of the present case, the board considers that the common general knowledge of the skilled person encompasses the scientific publications D19 to D22. These publications deal with the preparation of hemicellulose and provide a clear picture of the research activity in that field before the filing date of the patent in suit. Since, however, this field was fairly new, these research results had not yet found their way into textbooks. For these reasons, the content of these scientific publications is exceptionally considered to reflect the common general knowledge of the skilled person (see e.g. T 0051/87, OJ EPO 1991, 177).

The common general knowledge is also considered to comprise D18 (published in 2004, with no information on the exact publication date). Even if D18 were considered to be post-published (the filing date of the patent in suit is 18 March 2004), its content describes what was known before that date by reference to pre-published scientific articles such as D19 (see table of references on page 64-65).

5. Question 1

The first question relates to the meaning of the expression "molecular weight of a hemicellulose".

5.1 All parties agreed with the definition of hemicellulose provided in the patent in suit (paragraph [0006]), which recites that *"[H]emicelluloses are polysaccharides that are biosynthesized in the majority of plants"* and which complies with the definition given in the cited prior art (D1: page 3, first paragraph; D1, paper 1: page 360, left column, second paragraph; D7: page 367, first paragraph; D20: page 423, right

column, lines 4-14; D21: page 111, left column, second paragraph; right column, first paragraph).

5.2 Interpretation of the "molecular weight" of a hemicellulose

The objection of the respondents related to the meaning of the term "molecular weight". They argued that the invention was insufficiently disclosed because the skilled person did not know exactly what this term meant.

5.2.1 The board does not dispute the fact that the term "molecular weight", if considered in isolation, is unclear, nor that the patent in suit fails to provide any definition in order to assist the skilled reader. Furthermore, the description mixes "molar mass" (see page 4, lines 48, 54 and 55; page 6, lines 23 and 24) and "molecular weight" (page 2, lines 54, 56 and 57; page 3, lines 2, 21, 23, 32, 33, 34, 36, 37, 39 and 41; page 4, line 4; page 6, lines 49, 52 and 55; page 7, lines 1, 39, 43 and 47) and uses these two terms as synonyms.

5.2.2 However, the board does not consider that the skilled person would stubbornly consider this term in isolation and not in the context of the claimed subject-matter, which uses the molecular weight as a parameter for the definition of hemicellulose. It is, therefore, beyond any reasonable doubt that the skilled person for the reasons provided below would understand this term to mean "average molecular weight" and not an "absolute molecular weight" ranging between the claimed limits of 20 000 to less than 50 000 g/mol.

It is considered to be basic technical knowledge that naturally occurring polymers apart from proteins and nucleic acids are generally polydisperse and have a narrower or broader molecular weight distribution. This applies also to polysaccharides such as hemicelluloses.

Particular reference is made to D38 (see section 1.1.3, page 10, lines 1-2), which discloses that the biosynthesis of polysaccharides is governed by enzymes yielding a spectrum of chain lengths, so that the molecular weight has to be specified as an average.

Further reference is made to D37 (item 3) in which Professor Eisenbach states:

"*To begin with, the skilled person does not interpret, e.g., the figure 15,000 g/mol of Example 1 [of the patent in suit] as implying that the hemicellulose is monodisperse. A monodisperse polymer where all macromolecules have the same degree of polymerization (number of repeat units in the polymer chain) does not exist except for some proteins and polynucleic acids which are synthesized in living organisms by enzymatic catalysis*".

The board does not dispute the fact that the polydispersity of the hemicellulose might be as narrow as 1.1. The board stresses, however, that even such a narrow polydispersity does not mean that the hemicellulose is monodisperse. Reference is made to the statement of Professor Eisenbach (D37, item 3):

"*A hemicellulose with a polydispersity index M_w/M_n= 1.15 (Table 4 in D13, sample SS-2) is not monodisperse but contains components in a significant range of molar masses (see Figure 2 in Ref. D13). Further*

fractionation leads to samples of narrower but still polydisperse molecular weight distribution (see Figure 3 in D13)".

This is further confirmed by the cited prior art, which discloses various hemicelluloses having various polydispersities (see e.g. D19, page 200, table 3).

5.2.3 Regarding the isolated disclosure of D13 which concerns (quasi)monodisperse hemicellulose fractions, these fractions result from the chromatographic fractionation of polydisperse hemicellulose. In contrast to the disclosed chromatographic fractionation, the patent in suit does not require such fractionation for the hemicellulose of the claimed invention.

This is also confirmed by Dr Axegård (see D25, expert opinion filed by respondent 2), who states on page 2 that:

"*[m]onodisperse distributions are very seldom observed for polymers other than proteins*".

5.2.4 In summary, the skilled person is aware that hemicellulose naturally occurs as a polydisperse polymer having a certain average molecular weight and would understand that the term "molecular weight" in claim 1 refers to an "average molecular weight".

5.2.5 With regard to the further objections of the respondents the board takes the following view:

The term "molecular weight" would not be understood by the skilled person to mean that the hemicellulose has at least one molecule within the claimed molecular weight range. This interpretation is technically

meaningless since the molecular weight of one single molecule cannot have an impact on the properties of the claimed film.

The above contested term would not be understood by the skilled person to mean that all hemicellulose molecules must have a molecular weight within the claimed range, thereby excluding hemicellulose molecules with a molecular weight outside that range. This interpretation, which imposes a stronger restriction on the molecular weight than the interpretation as an average molecular weight, does not belong to the common general knowledge, nor does it find support in the patent in suit. In the field of polymer science it is not usual to specify the molecular weight in this way. Furthermore, such an interpretation would lead to the conclusion that individual molecules having a molecular weight outside the claimed range would have a harmful impact and would require removal of the harmful lighter or heavier molecules from hemicelluloses of natural sources. However, such a conclusion cannot be drawn from the patent in suit.

5.3 Interpretation of the "average molecular weight"

The respondents also objected to the meaning of the term "average molecular weight" because the skilled person did not know which type of average molecular weight was meant.

5.3.1 The board acknowledges that there are various types of average molecular weight which could be used to define a polymer, such as the number average molecular weight, the weight average molecular weight, or the z-average molecular weight. It is therefore necessary to clarify which type of average molecular weight the skilled

person would consider on the basis of the information disclosed in the patent specification and his general technical knowledge.

5.3.2 Paragraph [0027] of the patent in suit refers to the relation between the hemicellulose molecular weight and the film viscosity, which has been known in the art as a limiting factor for the mechanical properties of films and coatings obtained by such hemicelluloses (paragraph [0009]) in view of their use as packaging material (paragraphs [0035] and [0036]).

Furthermore, the skilled person in view of his knowledge and experience is aware that viscosity - and thus the mechanical properties - depends on the size of the molecules making up the bulk of the polymer sample, which means that it is much more dependent on the larger-sized molecules than on the smaller ones. These larger molecules - with a stronger influence on the polymer properties - contribute more to the weight average molecular weight and less to the number average molecular weight. Thus, the skilled person would understand that the polymer properties referred to in the patent in suit are determined by the weight average molecular weight rather than the number average molecular weight.

This is explained by Professor Eisenbach (D37, item 3), who states:

"*First, film forming properties of polymers or polymer systems are mainly controlled by the high molecular weight fraction of a polymer. This can be easily understood when considering that the formation of a free film or a coatings film from a polymer requires the flowing of the material which is directly related*

to the viscosity of the applied material.
The viscosity and viscous flow of a polymer solution or a polymer melt is primarily effected by the longer macromolecules which are more difficult to displace than shorter macromolecules first because of their larger mass and second because of their higher entanglement with other macromolecules in the system."

In this respect reference is also made to D17a (page 24, second paragraph), which discloses:

"The weight average molecular weight is a much better indicator of the properties to be expected in a polymer. The utility of M_n resides primarily in its use to obtain an indication of polydispersity in a sample by measuring the ratio M_w/M_n."

This leads to the conclusion that the patent in suit by disclosing the film properties and the hemicellulose viscosity in direct connection with the molecular weight of hemicelluloses provides the skilled person with the clear indication that it is the weight average molecular weight M_w which is the decisive parameter of the hemicellulose used for the manufacture of a film or a coating.

5.4 Measurement of the weight average molecular weight

The respondents objected to the method disclosed in the patent in suit for measuring the weight average molecular weight and argued that this method was not sufficiently disclosed so that the skilled person could obtain reliable results.

5.4.1 The board remarks that there is a method disclosed in the patent, example 1, which is suitable for measuring

the weight average molecular weight. In example 1 (see paragraph [0048]) the molar mass of the specific hemicellulose glucuronoxylan was measured using size exclusion chromatography (SEC). This was performed using a PSS column (Polymer Standards Service), a refractive index detector, a two-angle laser light scattering detector and a viscosimetric detector. The data were collected and calculated using the PSS WINGPC 6.0 software. Molar mass data were calculated from the viscosity and refractive index signals by using universal calibration using pullulan standards.

5.4.2 The respondents criticised the error measurement. However, the appellant explained at the oral proceedings - without being contradicted by the respondents - that the specific software used in the method of example 1 eliminated the error related to the type of hemicellulose tested. It also pointed out that the skilled person was aware that a measurement is always subject to a certain margin of error, which meant that he would interpret the experimental results accordingly. Thus the measurement error could not be regarded as an obstacle to the reworking of the invention.

5.4.3 The respondents also criticised the use of a universal calibration method with pullulan standards. However, the universal calibration method was a well-known technique at the filing date of the patent in suit and relied on calculation of the intrinsic viscosity from the viscosity data (as provided by the viscosity detector) and from the concentration (as measured by the refractive index detector). The universal calibration technique provides molecular mass data where required calibration standards are not available (see D27, page 335, section 10.7).

This is confirmed by Professor Eisenbach, who states (D37, item 4):

"*The universal calibration technique (Grubisic, Rempp and Benoit (1967)) used in the opposed patent is a method for overcoming these dependencies in SEC analysis of differently structured polymers. The technique makes use of the relationship between the molecular weight M, the size of the molecule (expressed as hydrodynamic volume v_h) and the intrinsic viscosity.*"

Similar comments are provided by Dr Axegård (see D25: page 5, second paragraph, last sentence), who states:

"SEC-analysis equipped with viscosimetric detector may provide the correct average molecular masses if calibrated by the universal calibration method, independent of pullulan standards."

Furthermore, the use of universal calibration on the basis of viscosity and refractory index data and pullulan standards, as disclosed in the patent in suit (paragraph [48]), was a method known in the art on the filing date of the patent. Reference is made to D19 (page 196, right column, section 2.3, fourth paragraph).

Accordingly, the skilled person would have no difficulties in obtaining the weight average molecular weight values reported in the patent by universal calibration using pullulan standards.

5.4.4 The board does not disregard the respondents' argument that D45 (pages 176 and 177) discloses that universal

calibration is convenient for the measurement of M_n rather than M_w.

The board remarks that D45 did not refer to universal calibration in general but concerned the specific case of a complex polymer. In that specific case, the M_n could be calculated exactly, whereas further information as to polydispersity would be required for calculation of the exact M_w. However, in that case, it had been possible to calculate an apparent M_w from the distribution curve of the complex polymer by treating the complex polymer as a simple polymer. This had also been done in the prior-art documents D18 (page 55, under the heading "Size Exclusion Chromatography", page 57, table II; page 60, table III) and D19 (section 3.2, in particular table 2), where the M_w of the hemicellulose was measured by universal calibration.

Thus, no matter whether M_w relates to the exact M_w or an apparent M_w, the disclosed method enables the skilled person to determine the M_w, and the disclosure of the patent in suit should be interpreted accordingly.

5.4.5 The board notes that the respondents argued on the basis of D25 that the skilled person when using the method of example 1 would obtain both the M_n and M_w values for the hemicellulose. They concluded that in the absence of any indication in the patent in suit the skilled person would not know which was the intended molecular weight for the definition of the hemicellulose.

The board confirms that according to the disclosure of D25 (page 3, second full paragraph) SEC using universal

calibration (pullulan standards) provides both M_n and M_w values and that the skilled person is confronted with the situation of having to make a choice between the M_n and M_w values. However, as already mentioned above, the skilled person in view of the general disclosure of the patent in suit, that the molecular weight is important in view of viscosity and film forming properties and specifically addresses the mechanical properties of the films and coatings, would use SEC in order to measure the weight average molecular weight of the hemicellulose.

5.5 Further objections were raised in relation to the hemicellulose having a molecular weight from 20 000 to less than 50 000 g/mol

5.5.1 The respondents alleged that the skilled person was not able to reproduce the claimed hemicellulose because he was not provided with any information relating to the structure, origin and extraction method of the hemicellulose.

The board, however, remarks that neither claim 1 nor the patent in suit require or imply any limitation for the hemicellulose beside the weight average molecular weight.

There is no requirement for a hemicellulose of a specific structure or monomer composition. The patent in suit (paragraph [0028]) discloses that xylans (the main hemicellulose of hardwood - see D1: abstract, first paragraph; D7: page 367, left column, lines 7-8) extracted from biomass such as wood, cereals, grass or herbs may be used, but that other hemicelluloses may also be used (paragraph [0024]).

Nor does the specific average molecular weight of claim 1 imply that the hemicellulose must be of a specific origin. The prior art discloses hemicelluloses with the same average molecular weight but from different origins and with different structure and monomer composition (see D19: page 198, table 2).

Furthermore, the hemicellulose is not limited by its extraction process. The patent in suit (paragraph [0028]) discloses extraction with water in aqueous alkali as a possible process leading to hemicellulose of the required molecular weight. This is a conventional method used in the art which is illustrated in the technical evidence D39-D41 provided by the appellant. This evidence uses the conventional alkaline extraction of hemicellulose from barley husks and yields the hemicellulose arabinoxylan of the required molecular weight (D40: Mw=38400 g/mol).

As far as the conditions of this extraction are concerned, the prior art discloses that they can vary and nevertheless lead to hemicellulose of the claimed weight average molecular weight (D13: tables 2 and 4; D19: table 2; and D21: table 6).

It is therefore concluded that the prior art provides the skilled person with the necessary information enabling him to obtain a hemicellulose of the required weight average molecular weight and to carry out the claimed invention without the alleged undue burden.

5.5.2 The respondents criticised the technical evidence of D39-D41 on the grounds that it related to a different extraction process since it comprised an enzymatic treatment. However, as explained by the appellant, this step is not essential and was introduced only for

comparison purposes, i.e. in order to prepare samples which differed from those claimed only in terms of their weight average molecular weight. This allowed a plausible conclusion to be drawn on the impact of the molecular weight on film formation. But even in this case, the hemicellulose obtained initially, i.e. before enzymatic degradation, had a molecular weight of 38 400 g/mol (D40, page 3; D41, page 2), which lay within the claimed range. It is therefore concluded that this argument of the respondents is irrelevant to the question of sufficiency.

5.5.3 The respondents contested the technical evidence of D39-D41 also on the ground that it was carried out using conditions for SEC measurement which differed from those of the patent in suit (paragraph [48]).

In the patent in suit the solvent system was made of DMSO:Water 90:10 + 0.05M LiBr, whereas in D39-D41 it was an aqueous 0.1M $NaNO_3$ solution. The respondents assumed that the solvent and the conditions as specified in the patent, if used in D39-41, would provide different values for the weight average molecular weight and would lie outside the claimed range.

However, the allegations of the respondents are not founded. The appellant confirmed with the additional experimental evidence of E3 that SEC measurements, conducted with the samples of D39 using the solvent and conditions as specified in the patent in suit, differed only marginally from the SEC results of D39 and that this difference did not affect the assignment of the samples to "comparative" or "inventive" examples. The appellant carried out a further test with an

arabinoxylan sample of a M_w close to the upper limit and showed that the M_w remained within the claimed range.

The board thus concludes that the hemicelluloses used in D39-D41 meet the features of claim 1 also when using the solvent as defined in the patent in suit.

5.5.4 A further objection concerning the technical evidence in D39-D41 related to the use of equipment from different manufacturers and the selection of the measurement temperature, which might have an impact on the value of the weight average molecular weight.

The board, however, considers that this objection is mere speculation because it does not rely on any technical evidence. On the one hand the molecular weight determination of a polymer by SEC was a well-established technique in the field of polymer chemistry, specifically in connection with hemicellulose, and on the other hand the capabilities and performances of this technique were known to the skilled person. Accordingly, the skilled person would have known how to conduct the SEC measurement described in the patent in suit in order to determine the weight average molecular weight of the hemicellulose.

5.5.5 The respondents finally objected to the absence of a step for the "removal of insoluble matter" (i.e. the elimination of solid particles) from the hemicellulose sample.

However, this does not constitute a difficulty for the realisation of the invention since the insoluble matter in question, which is believed to consist of fibre residues, lignin and other impurities in particle form, would inevitably be removed by the skilled person, who

is aware that particulate contaminants risk impairing the properties of the film and may cause holes and other damage. In order to manufacture a film with the advantages of the claimed invention, he would therefore use a hemicellulose in a sufficiently pure form and would proceed to the removal of particulate contaminants if necessary.

6. Question 2

This question relates to the manufacture of a polymeric film or coating from a composition comprising as first component hemicellulose of a specific molecular weight and at least a further component selected from plasticisers, cellulose and an oligomer or polymer having a thickness of 10 µm or less.

6.1 Regarding the composition of claim 1, the skilled person has no difficulties in reproducing it. The component "hemicellulose" having a molecular weight from 20 000 to less than 50 000 g/mol has been assessed in point 5 above. Concerning the component "plasticiser", the board makes reference to the patent in suit: paragraph [0039] discloses compounds to be used as plasticisers for the claimed invention, and paragraph [0040] discloses the suitable weight content in the film or coating. Concerning the component "cellulose", the board makes reference to the patent in suit, in particular to paragraph [0041], which discloses the necessary information. Concerning the component "oligomer or polymer", the board makes reference to paragraph [0042] of the patent in suit.

6.2 Regarding the manufacture of a film or a coating having a thickness of 10 µm or less the board acknowledges that the patent in suit does not contain any example

falling within the scope of claim 1 as amended. Example 5, the closest to the claimed subject-matter, discloses the preparation of a film with hemicellulose arabinoxylan having a molar mass of 34 000 g/mol whose thickness is 30-40 µm and not 10 µm or less as claimed.

6.3 However, the disclosure of a specific example falling within the scope of the claimed subject-matter is not a necessary prerequisite for sufficiency of disclosure, as long as the teaching of the patent considered in its entirety enables the skilled person to prepare embodiments of the claimed invention (T 1437/07, points 38 *seq.*).

6.4 However, the appellant has filed experimental report E1 which shows that it is possible to prepare films or coatings with the claimed thickness of 10 µm or less. In E1 the appellant used the hemicellulose "arabinoxylan" with a weight average molecular weight of 21 000 g/mol as determined by SEC and followed the manufacturing procedure of example 2 of the patent in suit. According to this procedure, the arabinoxylan was mixed with 20% of sorbitol (the further component of the claim) and was processed to provide a coating with a thickness of 10 µm onto a board using wired wound bars. The mechanical properties were evaluated by creasing and folding the samples and measuring the grease barrier (KIT) before and afterwards by the standard TAPPI 559 method (D34; E2). The mechanical properties of the coating were satisfactory, a result confirming the coating integrity.

Further experimental evidence has been filed in D36 and D40 (page 3) which illustrates that it is possible to manufacture a free-standing film with a thickness of 8(±2) µm based on hemicellulose arabinoxylan from

barley with a weight average molecular weight of 38 400 g/mol and containing 35 wt% sorbitol (the further component of claim 1) based on dry weight.

D41 and E3 also provide evidence for films and coatings with a thickness below 10 µm manufactured from hemicellulose such as barley arabinoxylan (Mw: 38 400 g/mol) mixed with 35 wt% sorbitol based on dry weight, or konjak glucomannan (Mw: 44 900 g/mol) mixed with 35 wt% sorbitol based on dry weight. The films which had a thickness below 10 µm were free-standing, flexible and easy to handle without any signs of cracking.

6.5 Counter-evidence D32 has been submitted by respondent 3 in order to show that similar hemicellulose compositions when processed to provide films with a thickness of 8 µm did not constitute a free-standing, continuous film but a highly cracked thin layer.

The board refers to example (e) of D32, which used hemicellulose glucomannan extracted from spruce chips with an average molecular weight (M_p) of 27 000 g/mol. According to this example the hemicellulose was mixed with sorbitol in an amount of 35 wt%, the mixture was dissolved in water, cast into a Petri dish and left to dry.

This technical evidence cannot, however, be considered relevant because the hemicellulose is not defined in the same manner as in the claimed invention.
In example (e) it is defined by reference to its M_p, whereas in claim 1 it is interpreted to refer to its M_w. M_p is the maximum value of the molecular weight distribution (see D22, page 90, footnote (a) to table 1; D25, page 2, first line above the figure).

The board thus concludes that the counter-evidence does not challenge the manufacture of free-standing films or coatings with a thickness of 10 µm or less from a hemicellulose with a Mw from 20 000 to less than 50 000 g/mol.

6.6 As to the alleged counter-evidence in D42 (a post-published document of the research group of the present inventors), which would show that it was not possible to make free-standing hemicellulose films with the claimed thickness, the board makes the following remarks:

Samples AX1 and AX4 (page 273, section 3.7 and table 2) on which the allegation is based did indeed contain hemicellulose materials (arabinoxylan fractions) having molecular weights within the claimed range, namely 43,000 and 34,300 g/mol respectively. However, the films of samples AX1 and AX4 were made out of materials which contained substantial amounts of protein and lignin impurities (page 271, figure 3). These impurities are expected to have a negative impact on film formation, which explains why the films were rather brittle (page 274, left column, first full paragraph).

6.7 With regard to the criticism of the manufacturing procedure used in the experimental evidence of D39-D41 which applied conditions different from those disclosed in the patent in suit, the board makes the following remarks:

The differences are:

- the temperature (95°C in the patent vs. 90°C in D39-D41) and the stirring time (15 vs. 30 minutes) when preparing the film forming or coating solutions,
- the substrate for coating (plastic vs. board), and
- the drying conditions (air-dried vs. hot air circulation).

These differences are marginal, and it is neither apparent nor substantiated by the respondents how they could have a technical impact, let alone be relevant, for the evaluation of sufficiency. The respondents did not show any difference between film-forming or coating-forming solutions prepared at different temperatures. Furthermore, it is neither apparent nor plausible how the claimed invention would depend on the substrate, since the patent encompasses any substrate. Finally, the drying conditions used in the evidence of D39-D41 were harsher than those of the patent in suit. Consequently, if drying had a negative impact, this would be more pronounced in D39-D41 (where a lower water content was used and the risk of the film becoming brittle was greater). However, the coatings of D39-D41 had the desired quality which means that the coatings obtained under the less harsh drying conditions of the patent in suit should be of even better quality.

7. Question 3

This question concerns the enablement of the skilled person to reproduce the invention over the whole breadth of the claim. However, the respondents who raised this objection and who bear the burden of proof have never technically substantiated this allegation. Therefore this objection is dismissed.

8. In view of the above considerations the board concludes that the claimed invention is disclosed in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art.

9. Remittal

The appellant and respondents 2 and 3 requested remittal of the case to the opposition division if the board should consider the invention to be sufficiently disclosed. Since the outstanding issues of novelty and inventive step were not addressed in the decision under appeal, the board in exercising its power under Article 111(1) EPC and in accordance with the parties' requests remits the case to the opposition division for further prosecution.

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 for further prosecution on the basis of claims 1-14 as filed with letter dated 8 October 2009 (main request).

The Registrar: The Chairman:

I. Aperribay W. Sieber

Decision electronically authenticated