(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 533 927 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
04.09.2019 Bulletin 2019/36

(21) Application number: **18159525.7**

(22) Date of filing: **01.03.2018**

(51) Int Cl.:
D21H 17/16 (2006.01) *D21H 17/17* (2006.01)
D21H 17/28 (2006.01) *D21H 17/66* (2006.01)
D21H 21/16 (2006.01) *D21H 21/56* (2006.01)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(71) Applicant: **Holmen AB**
114 84 Stockholm (SE)

(72) Inventors:
- **ESKILSSON, Martin**
820 11 Vallsta (SE)
- **LINDGREN, Johan**
825 32 IGGESUND (SE)
- **TIMMERMANN, Brita**
824 41 Hudiksvall (SE)

(74) Representative: **Zacco Sweden AB**
P.O. Box 5581
114 85 Stockholm (SE)

(54) METHOD FOR PRODUCING FIBROUS WEB, PAPER OR PAPERBOARD AND PAPER OR PAPER BOARD PRODUCT

(57) The invention is related to a method for producing a fibrous web, a paper or paper board comprising the steps of:
- providing a furnish comprising pulp,
- providing a surfactant to said furnish,
- mixing the furnish with the surfactant in order to achieve a foamed furnish,
- providing the foamed furnish to a wire that dewaters the foamed furnish in order to achieve the fibrous web, paper or paper board, wherein the pulp of the furnish comprises a chemical pulp preferably to an amount of 25-100 % BDT, preferably 50-100 % BDT, more preferred 70-100 % BDT, more preferred 85-100 % of the pulp, most preferred essentially 100 % BDT of the total pulp content in BDT. The invention is also related to a paper or a paper board produced and a packaging box product.

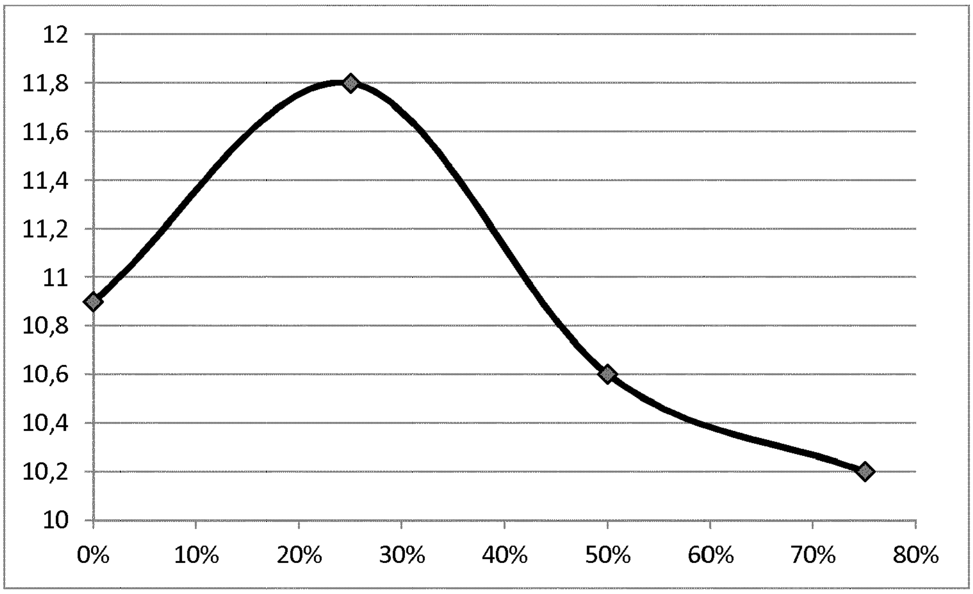


Fig. 5

EP 3 533 927 A1

Description

[0001] The present invention is related to a method for producing a fibrous web according to claim 1 and a paper or paper board product according to claim 16. It is also related to a paper or paper board product and also a packaging box product.

BACKGROUND

[0002] In general foam is not desired on a paper or paper board machine. In general many actions are taken in order to prevent foam on the paper machine.

[0003] It is known in the art to use a surfactant in furnish for providing a paper in combination with a mainly mechanically paper pulp.

SHORT DESCRIPTION OF THE INVENTION

[0004] Foam in general paper or paper board production will lead till less control of the properties of the finished product. A problem with foam in paper or paper board production is that thickness of the fiberweb will vary more than compared with a water formed paper or paper board product. A further problem is that the density of the product may vary. A further problem is that formation may be slower and speed of the paper machine may need to be reduced. A further problem is that the fibre mat that is formed into a paper or paper board may break more easily. One reason for this is that the tensile strength of the paper or paper board is in general reduced if foam occurs on the paper machine. A further problem is that with if foam occurs in the furnish it is difficult to achieve a higher surface weight paper. A further problem when foam occurs is that the furnish will split in terms of hydrophobic and hydrophilic particles and the formation of the fibre layer will not be homogenous. If adding a surfactant on purpose despite the above discussed disadvantages with foam, a disadvantage is that other components of the furnish, such as sizing agents will have its effect on for example retention on the paper machine to be affected as the surfactant risk to impede sizing properties. A further problem with active foaming is that the dewatering on the paper machine can deteriorate.

[0005] The present invention is related to an improved method for producing a fibrous web. It is may also be a method for producing a paper or a paper board. The method comprising the step of providing a furnish comprising pulp. The method also comprising to provide a surfactant to said furnish. The method also comprising to mix the furnish with the surfactant in order to achieve a foamed furnish. The method also comprising the step to provide the foamed furnish to a wire that dewaters the foamed furnish in order to achieve the fibrous web, paper or paper board. Wherein the pulp of the furnish comprises a chemical pulp preferably of a content of 25-100 % BDT the total pulp content in BDT. It is also preferred that the chemical pulp content is 50-100 % BDT the total pulp content in BDT. The amount of chemical pulp may be 70-100 % BDT in the method. The amount of chemical pulp may be 85-100 % the total pulp content in BDT. The amount of chemical pulp may be essentially 100 % BDT the total pulp content in BDT.

[0006] The effect of the method is that foaming can unexpectedly be used with good results in providing a fibrous layer, paper or paper board, despite the given disadvantages above. In particular the bulk of products made from the chemical pulp can be increased. A further advantage is that the produced product achieves 10% added thickness compared with a water sample. Bulk can also be increased by over 100% if no wet pressing is performed. But in general at least 10 % or even 13 % can be achieved in increased bulk. And further by using surfactant floc size of hand sheets can be reduced by 20%, see also figure 3. In figure 3 the first bar on left refers to a hand sheet made from a furnish with only water and the second bar refers to a foamed furnish using an anionic surfactant, and the third bar refers to a hand sheet made from a furnish mixed with a non-ionic surfactant. It is also possible to achieve a modulus of elasticity that is same as a water formed sample. By increasing the amount of chemical pulp in the method the advantages is further increased that was already seen above.

[0007] A further development of the method is disclosed in claim 2.

[0008] The advantage of adding a sizing agent is that the foamed furnish will have better mechanical properties when formed to a fibrous web, a paper or paper board, despite the known disadvantages with a foamed furnish.

[0009] A further development of the method is disclosed claim 3.

[0010] A chemical pulp is actually often considered to give strong paper products as the fibres are long and can add strength by their own mechanical properties. Thus adding a cationic polyelectrolyte is often considered not necessary in this context. However in this context improvement of the mechanical properties given is despite this context, adding a cationic polyelectrolyte gives a better paper product in particular in terms of z-strength, i.e. cross sheet strength in thickness direction.

[0011] A further development of the method is disclosed claim 4.

[0012] It is an advantage to add alum as it improves the general properties of the furnish. It is an advantage to add PVAM as it increases the Z-strength and improves dewatering properties. Thus PVAM allows for a faster machine speed.

Also the retention is improved by PVAM. To add Bentonite is not a straight forward operation in the context of a foamed furnishes. Bentonite will reduce the mechanical properties of the furnish when producing a paper or paper board product. Bentonite will reduce the possibility of single fibres to attach or entangle to other fibres in the fibrous web or paper or paper board. PAM gives better strength. Silica gives a higher drainage rate and better formation.

[0013] A further development of the method is disclosed claim 5.

[0014] A hardwood pulp will in general be less performant than a soft wood pulp when considering mechanical properties. Thus it is not a straight forward operation to use foam on a furnish that is mainly made from hard wood. A soft wood pulp will be a stronger pulp in general. However as soft wood is in general chosen when a stronger paper or paper board is desired in respect of mechanical properties, it will not be a straight forward operation to make a foamed furnish from with soft wood fibres. In particular it has been found advantageous to mix the pulp with broke. It surprisingly gives better foaming properties for some particular surfactants. The fibre content of the broke will generally follow the fibre content of the fibre web or paper or paper board product produced in the mill.

[0015] A further development of the method is disclosed claim 6.

[0016] The advantage of an anionic surfactant is better formation of foam in general in the method as described. In particular sodium dodecyl sulphate only requires very low dosage for same amount of foam, compared with other surfactants. Anionic surfactants can also have higher air content than other surfactants. Surprisingly also the time to reach a predetermined air content of the foam is not sensitive to higher amount of broke than for a pure virgin chemical pulp, with an anionic surfactant. Glycolic acid ethoxylate lauryl ether gives the advantage of reaching a predetermined air content of the foam at almost same time at high amounts of broke as with no broke added at all.

[0017] A further development of the method is disclosed claim 7.

[0018] The advantage of an anionic and multi charged surfactant is that it is not sensitive to a pulp with higher amount of broke than furnish based on pure virgin chemical pulp.

[0019] A further development of the method is disclosed claim 8.

[0020] The advantage of an anionic surfactant with an ethoxylate chain is that the time to reach a predetermined air content of the foam is faster in a furnish having a high amount of broke than a furnish based on pure virgin chemical pulp.

[0021] A further development of the method is disclosed claim 9.

[0022] The advantage of a non-ionic surfactant is that it gives a higher bulk than an anionic surfactant.

[0023] A further development of the method is disclosed claim 10.

[0024] The advantage of an amphoteric surfactant is a very good stability of produced foam.

[0025] A further development of the method is disclosed claim 11.

[0026] In a multiply product there is possible to have an additional advantage if separate plies are feed with a furnish prepared according to the method. Thus is possible to adapt the mechanical properties of a paper or board product and providing the foamed furnish to a layer that need not same strength properties than other plies.

[0027] A further development of the method is disclosed claim 12.

[0028] In a middle ply it is possible to use the reduced mechanical properties of the foamed furnish and letting other plies of the furnish add strength to the finished product. In particular it is possible to ad bulk to a middle layer. This is also possible if same pulp is used for all layers but only a middle layer has foamed furnish of this pulp. Any number of plies is possible to add to a paper or paper board product. It is thus possible to make a five ply product. In this case on or two or three of the inner plies can be provided with the foamed furnish.

[0029] A further development of the method is disclosed claim 13.

[0030] The provided furnish can be a bleached furnish. The provided furnish can be a non-bleached furnish. A bleached furnish will have better optical properties and better whiteness. A non-bleached furnish will have a higher yield and thus cost less.

[0031] A further development of the method is disclosed 14.

[0032] It has surprisingly been found that for certain amounts of broke amount in the furnish a better the time to reach a predetermined air content of the foam is higher. Chemical fibres in particular with broke provides for very good ability to reach a predetermined air content of the foam in short time.

[0033] A further development is disclosed in claim 15.

[0034] It is a clear advantage to not need to add any particular mechanically treated fibres in the nano cellulose range. This would be a further step that would require equipment for providing this cellulose or even acquiring this cellulose from a third party, thus decreasing cost effectiveness of the method.

[0035] A further development is disclosed as a paper or paper board product in claim 16.

[0036] A paper or paper board product made according to the disclosed method is lighter for the same volume compared with same product made with same pulp without foamed furnish. In a several ply product it will also be both lighter and have a higher bending stiffness compared with a homogenous paper or paperboard product if added to a middle layer of the product.

[0037] A further development is disclosed in claim 17. Broke in content as disclosed in in the product of claim 17 has surprisingly been found to give a same or faster times to reach a predetermined air content of the foam.

[0038] A further development is disclosed in claim 18.

[0039] Chemical fibres in particular in combination with broke gives advantages in terms of time to reach a predetermined air content of the foam.

[0040] A further development is disclosed as a packaging box in claim 19.

[0041] If a packaging box product is made from the paper or paper board product it will be lighter and possibly stronger than a product made without foamed furnish. This is a clear advantage as a better economy on natural fibres can be achieved and less weight is needed when transporting and distributing the packaging box.

LIST OF DRAWINGS

[0042]

Figure 1 discloses a density difference for a formed hand sheet according to the invention.

Figure 2 discloses a bulk difference for a formed hand sheet according to the invention.

Figure 3 discloses the reduced floc size for different surfactants.

Figure 4 discloses reduction in Z-strength for two surfactants.

Figure 5 discloses the mixing time to reach 50 % air content as a function of the amount of broke in furnish in relation to a anionic surfactant with an ethoxylate chain.

Figure 6 discloses the mixing time to reach 66 % air content as a function of the amount of broke in furnish with an anionic ethoxylate chain surfactant.

Figure 7 discloses the improved half time of fibre-foam mixture as a function of the broke amounts for an anionic surfactant with an ethoxylate chain surfactant.

Figure 8 discloses the amount of broke in furnish in relation to the mixing time to reach 50 % air content with an anionic multi charged surfactant.

Figure 9 discloses the improved half time of fibre-foam mixture as a function of the broke amounts for an anionic multi charged surfactant.

Figure 10 discloses the mixing time to reach 50 % air content as a function of the amount of broke in furnish in relation to an anionic surfactant.

Figure 11 discloses the mixing time to reach 50 % air content as a function of the amount of broke in furnish in relation to a non-ionic surfactant.

Figure 12 discloses the mixing time to reach 50 % air content as a function of the amount of broke in furnish in relation to an amphoteric surfactant.

Figure 13 discloses the mixing time to reach 66 % air content as a function of the amount of broke in furnish with an anionic surfactant.

Figure 14 discloses the mixing time to reach 66 % air content as a function of the amount of broke in furnish with an non-ionic surfactant.

Figure 15 discloses the mixing time to reach 66 % air content as a function of the amount of broke in furnish with an amphoteric surfactant.

Figure 16 discloses the mixing time to reach 66 % air content of a foamed furnish with anionic and multicharged surfactant.

Figure 17 discloses the improved half time of fibre-foam mixture as a function of the broke amounts for an anionic surfactant.

Figure 18 discloses the improved half time of fibre-foam mixture as a function of the broke amounts for a non-ionic surfactant.

Figure 19 discloses the improved half time of fibre-foam mixture as a function of the broke amounts for an amphoteric surfactant.

DETAILED DESCRIPTION

[0043] The present invention in related to a method for producing a fibrous web or paper board product. The paper can be any type of paper and the paper board product can be any paper board product. Preferred is a paper board product.

[0044] The method involves the step of providing a furnish. The furnish comprises a pulp. The pulp could be any pulp but it is preferred that the furnish comprises a chemical pulp. That is a pulp that has been produced by an essentially chemical process, such as the Kraft pulp process or a sulphite process.

[0045] In a further step there is provided a surfactant the furnish. The surfactant has the ability to provide a foam if the furnish is mixed in a subsequent step.

[0046] The furnish as produced is then provided to a wire for dewatering and producing a paper or paper board product.

[0047] The amount of chemical pulp can vary in a preferred way of performing the method there is an amount for 25%-100 % BDT of chemical pulp in the furnish. But more preferred there is a higher amount of chemical pulp such as 50 -100 % or 70-100 % chemical pulp. There can also be at least 85 % chemical pulp BDT in the furnish. The other pulps that can be mixed in are for example CTMP or CMP pulp or TMP. It should be understood that in the meaning of the disclosure Chemical pulp can also be broke that is prepared from chemical pulp. Thus the meaning is that the fibre content of the furnish has its origin from a process involving chemicals as an essential part of the preparation of the fibres to be used in the furnish. One such process is the KRAFT process. Other processes involve Sulphite cooking.

[0048] In a most preferred step the amount of chemical pulp is 100 % or essentially 100 % BDT, i.e. the fibres of the furnish comes from a previous chemical process.

[0049] The furnish may be bleached or unbleached.

[0050] The method can be further developed by adding a sizing agent. As sizing agent it is proposed to use AKD or ASA or starch or even mixtures of these.

[0051] The method can also involve a step of adding starch as a cationic polyelectrolyte. This will indeed augment the strength properties of the paper or board product.

[0052] In further step of adding of alum, and/or PVAM and/or Bentonite and/or PAM, and/or Silica, can be performed. A filler such as bentonite will help to make the product more cost effective and will also augment the opacity.

[0053] The type of fibres used in the method is preferred to be a mixture of softwood and hardwood fibres. However both pure soft wood or hardwood pulps can be used.

[0054] The preferred surfactant used may be an anionic surfactant. The type of anionic surfactant can be anionic and multi charged or anionic with an ethoxylate chain. One preferred surfactant is an anionic surfactant with a hydrophobic alkane section comprising at least 10 carbon atoms, preferably comprising a hydrophilic end comprising sulphur and oxygen, most preferred Sodium Dodecyl Sulphate also known as SDS. One particular advantage of this surfactant is that is particularly fast to reach 50 % air content. As can be seen figure 10, where it as a consistent performance from below 5 seconds up to near 7 seconds to achieve this. On the X-axis is disclosed the broke content which will be discussed further below. But as can be seen in figure 10 the fastest time to reach 50% air content is with 50 % broke in the furnish. Also when studying figure 13 the times to reach 66 % air content it can be seen how effective and fast SDS is for reaching 66 % air content. And in relation to the broke content not much variation is observed and a low value is achieved at 50 % broke content. Notably also at 75 % broke content the time to reach 66 % air content is lower than for 0 % broke content.

[0055] The surfactant used can also be an anionic and multicharged surfactant, such as described below in example 2. Generally it can be called Polyoxyethylene (20) sorbitan monolaurate. In figure 8 it can also be seen that the fastest time to reach 50 % air content increases from 30 % broke content and upwards. This is much unexpected. In figure 16 it can be seen the values for reaching 66 % air content with same furnish as for figure 8. As can be seen in figure 16 the time to reach 66 % air content with same furnish is very linear for the anionic multicharged surfactant. Fastest time is reached at 50 % broke content.

[0056] The surfactant used can also be an anionic with an ethoxylate chain as seen in example 1 below. In figure 5 it can be seen that the time to reach 50 % air content of the foamed furnish. As can be seen the time is lowest for higher amounts of broke from 30 % of broke an onwards. This is as mentioned previously unexpected. In figure 6 it can further be seen that the time to reach 66 % aircontent is even more clear on that the more broke that is a great advantage in reaching faster times to 66 % air content.

[0057] The surfactant can also be a non-ionic, preferably a surfactant comprising multiple EO groups. As can be seen in figure 11 a fast time to reach 50 % air content in the foamed furnish is archived and also as with previous surfactant

50 % broke content discloses the fastest time. With regard to times to reach 66 % air content it can be seen in figure 14 that the time for any content of broke is very linear and also for this surfactant the time to reach 66% air content is faster for 75 % broke content compared with 0 % broke content. See also example 5 below.

[0058] The surfactant can also be an amphoteric surfactant, such as a surfactant is described in Example 4. A best value of mixing time is reached at 25 % broke content. Also it can be seen that a broke content over 50 % gives lower values of mixing times to 50 % air content. Figure 15 discloses the times for mixing to 66 % air content for an amphoteric surfactant as seen in example 4. The time for mixing with larger amounts of broke flats out for higher amounts of broke and the derivative of the curve approaches 0.

[0059] With regard to halftimes for created foamed furnishes related to broke content one can see in figure 7 the anionic ethoxylate chain surfactant, figure 9 Anionic multicharged surfactant, figure 17 anionic surfactant, figure 18 non-ionic surfactant and figure 19 amphoteric. As can be seen figure 7 and 9, 17 and 19 gives increased half times the higher the broke content. And as seen in figure 18 half times is not affected by higher broke content. Thus the stability of the foam is not affected by the broke content.

[0060] The method is performed by providing the furnish to a wire. This is made with conventional technology on a paper or paper board machine. It is preferred to provide a foamed furnish to a middle layer of the paper or paper board. This gives as seen higher bulk and a thicker paper or paper board. The layers are provided by three or more head boxes that are installed on the paper machine. The outer layers of such a product are preferably not foamed. Thus a sandwiched product is given that has higher bulk in middle layer, see also figure 1, 2. In figure 1 and 2 the first bar on left is refers to a hand sheet made from a furnish with only water and the second bar refers to a hand sheet made from a foamed furnish using an anionic surfactant, and the third bar refers to a hand sheet made from a furnish mixed with a non-ionic surfactant.

[0061] By having several head boxes it is possible to consecutively ad furnish to the fibrous web that is being manufactured.

[0062] In particular it is disclosed that mixing broke in a furnish is advantageous when using a foam forming technology. Example 1 below discloses this. The amounts that are advantageous are broke in the amount of 20-90 % BDT more preferred 25-90 % BDT, even more preferred 50 %-90 % BDT, or most preferred 50-75 % BDT.

[0063] The broke should be defined as being a recycled fibre source that has not been in use for the end product such as a packaging box a paper product or the like. Instead it is a recycled fibre from the production within a paper mill itself. It should also be understood that the broke used has its origin from a pure chemical fibre, if the paper mill is producing products with a pure chemical pulp. Chemical in this context means that it has its origin from for example the KRAFT process in a paper mill or the like. Broke does not mean a recycled fibre that has its origin from for example old prints such as newspapers or the like. In the context of this disclosure the broke comprises, up to 10 % filler. The filler is mainly to be understood to be ground calcium carbonate or kaolinite. There are also normal chemicals used in board production comprised such as binders such as latex, and/or bentonite, and/or colouring agents, and/or carriers of whitening agents, and/or hardeners, and/or fluorescent whitening agent, and/or optical whitening agent, and/or thickeners, and/or viscosity agents, and/or sodium hydroxide, starch, and/or poly vinyl amines, and/or PAM, and/or crosslink agents, and/or silica, and/or alum, and/or PVAM, and/or sizing agents such as AKD or ASA. Even if the broke is defined as having a chemical origin the broke may contain a certain amount of mechanical fibres. Broke is a recycled product with in a paper mill. If the paper mill is using a mixture of other pulps, such as mechanical pulps in its production the amount of chemical fibre in the fibre content of the broke will vary. In particular the chemical fibre content, i.e. pulp content of chemical fibres of the broke may be 25-100 % BDT, preferably 50-100 % BDT, more preferred 70-100 % BDT, more preferred 85-100 % of the pulp, most preferred essentially 100 % BDT of the pulp in the broke.

[0064] It is not desired to use nanocellulose in the present method. Nanocellulose is defined as a nano-structured cellulose. This may be either cellulose nano fibres (CNF) also called microfibrillated cellulose (MFC), nanocrystalline cellulose (NCC or CNC), or even a bacterial nanocellulose, which refers to nano-structured cellulose produced by bacteria.

[0065] CNF is a material composed of nanosized cellulose fibrils with a high aspect ratio (length to width ratio). Typical fibril widths are 5-20 nanometers with a wide range of lengths, typically several micrometers. It is pseudo-plastic and exhibits thixotropy, the property of certain gels or fluids that are thick (viscous) under normal conditions, but become less viscous when shaken or agitated. When the shearing forces are removed the gel regains much of its original state. The fibrils are isolated from any cellulose containing source including wood-based fibres (pulp fibres) through highpressure, high temperature and high velocity impact homogenization, grinding or microfluidization (see manufacture below).

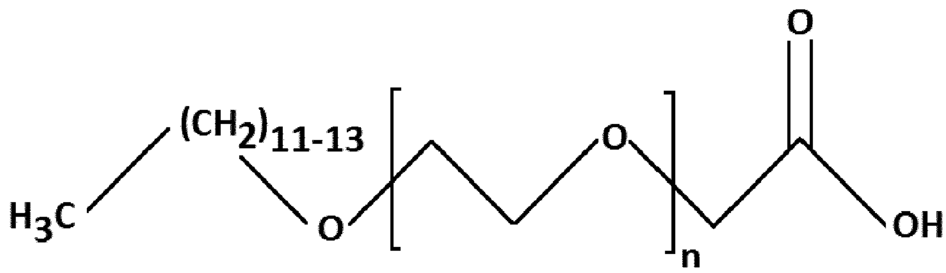
[0066] Nanocellulose can also be obtained from native fibres by an acid hydrolysis, giving rise to highly crystalline and rigid nanoparticles (often referred to as CNC or nanowhiskers) which are shorter (100s to 1000 nanometers) than the nanofibrils obtained through homogenization, microfluiodization or grinding routes. The resulting material is known as nanocrystalline cellulose (NCC or CNC).

EXAMPLES

[0067] In all examples below the pulps are a pure chemical KRAFT pulp that is a fresh never dried pulp, or a dried pulp and broke from a pure chemical pulp.

EXAMPLE 1

[0068] Figure 5 discloses the amount of broke in relation to the mixing time to reach 50 % air content. The used surfactant was glycolic acid ethoxylate lauryl ether, which is an anionic ethoxylate chain, with the general formula:



[0069] As can be seen the higher the broke content the lower the time to reach 50 % air content when mixing a furnish comprising different values of broke.

Table 1

Broke	SW Not Dried	SW+HW Dried
0%	50%	50%
25%	50%	25%
50%	50%	0%
75%	25%	0%

[0070] Table 1 discloses different pulps in a furnish where SW is soft wood and HW is hard wood.

[0071] The finished product will be ideal for making a packaging box product, with a generally lower density than a conventional paper or paper board.

[0072] The broke was standard broke from the production of board from chemical pulp. Thus it is broke that is the result of internally recycled paper or paper board products which have been milled gently and water has been added such that a broke furnish has been achieved that then has been mixed with virgin pulp. The broke comprised in addition to fibres from a KRAFT process cooking, fillers, mainly GCC and kaolinite, and/or binders such as latex, and/or bentonite, and/or colouring agents, and/or carriers of whitening agents, and/or hardeners, and/or fluorescent whitening agent, and/or optical whitening agent, and/or thickeners, and/or viscosity agents, and/or sodium hydroxide, starch, and/or poly vinyl amines, and/or PAM, and/or crosslink agents, and/or silica, and/or alum, and/or PVAM, and/or sizing agents such as AKD or ASA.

[0073] As can be seen for higher amounts of broke, the time for achieving 50 % air content with the chosen surfactant goes down. The same difference is found also when measuring mixing time to 66% air content. However for this value the time to reach 66 % air content goes down for all points up to 75 %, see figure 6.

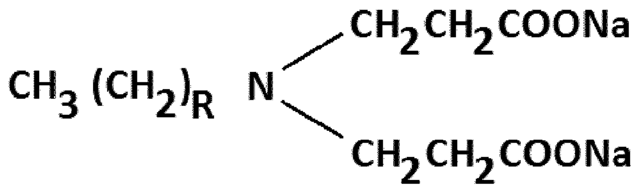
[0074] Figure 7 discloses the improved half time of fibre-foam mixture when considering the same broke amounts. As can be seen for higher amounts of broke the halftime is considerably increased.

[0075] In a further example it is disclosed further effects with the use of broke in the furnish.

EXAMPLE 2

[0076] Same furnish and broke was used as in Example 1.

Figure 8 discloses the amount of broke in relation to the mixing time to reach 50 % air content. The used surfactant was commercially available an anionic multi charged surfactant. With the general formula:



[0077] As can be seen the higher the broke content the lower the time to reach 50 % air content when mixing a furnish comprising different values of broke.

[0078] The finished product will be ideal for making a packaging box product, with a generally lower density than a conventional paper or paper board.

[0079] The broke was standard broke from the production of board from chemical pulp.

[0080] As can be seen for higher amounts of broke, the time for achieving 50 % air content with the chosen surfactant goes down.

[0081] Figure 9 discloses the improved half time of fibre-foam mixture when considering the same broke amounts. As can be seen for higher amounts of broke the halftime is considerably increased.

[0082] Figure 16 discloses the time for achieving 66 % air content with the chosen surfactant.

EXAMPLE 3

[0083] Same furnish and broke was used as in Example 1.
Also in example 3 that follows there are an advantage disclosed that is related to what has been discussed regarding SDS and the amount needed in a foam forming process.

[0084] A furnish comprising 25 % soft wood never dried pulp and 75 % broke pulp was used for adding surfactants. Mixing was performed and surfactant was added until the Vortex closed. The consistency was 1,1 %.

[0085] With SDS-sodium dodecyl sulphate the vortex closed at 0,6 g/l of added surfactant.

[0086] Anionic multi charged surfactant required 2,0 g/l of added surfactant.

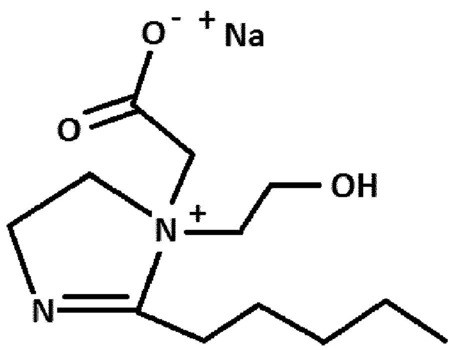
[0087] Glucolic Acid Ethoxylate Lauryl Ether required 4,5 g/l.

[0088] SDS has the general formula:

[0089] SDS needed very small amounts in order to achieve a good very fast time to 50 % air content as seen in figure 10. Also as seen in figure 10 the fastest times is achieved around 50 % broke content. Also figure 13 discloses time to reach 66 % air content for the above surfactant. In figure 17 the halftimes of the fain using SDS is disclosed in relation to broke content and the above surfactant.

EXAMPLE 4

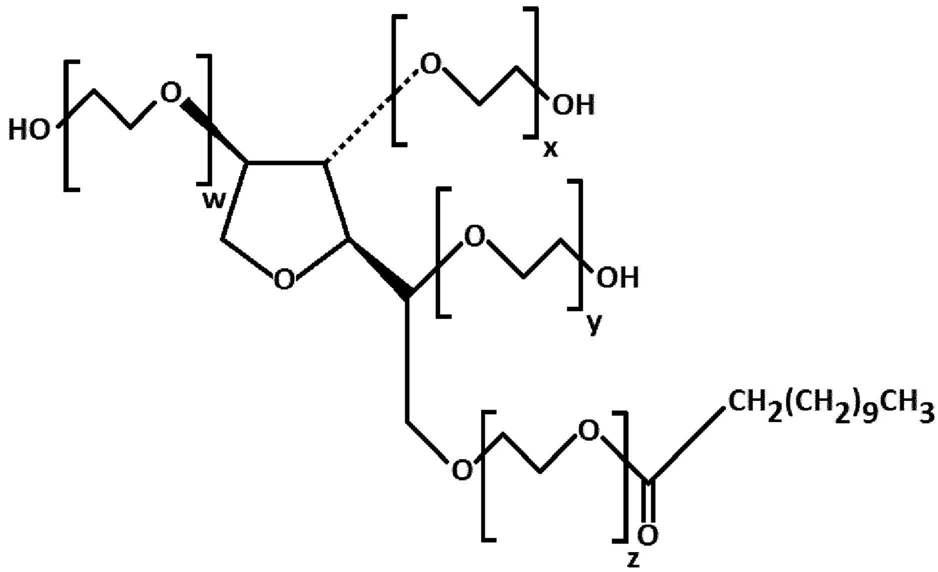
[0090] Same furnish and broke was used as in Example 1.
An amphoteric surfactant was used with different amounts of broke in the furnish. As can be seen in figure 12 in terms of time in seconds to reach 50 % air content of the foamed furnish with a differing broke content. As can be seen a broke content of over 50 % gives lower mixing times to 50 % air content. And also a low value for 25 % broke is achieved. The following general formula describes the surfactant used,



[0091] Figure 15 discloses the time to reach 66 % air content for the surfactant above to broke content. As can be seen the lowest times is reached around 50 % broke content. Half times for foamed furnish using the above surfactant in general goes up with higher broke content, see figure 19 for the surfactant of example 4.

EXAMPLE 5

[0092] Same furnish and broke was used as in Example 1.
An non-ionic surfactant was tested with different amounts of broke in the furnish, this can be seen in figure 11. As can be seen the tested broke content gave a fast time to 50 % air content of the foamed furnish when mixing and for 50 % broke content the fastest time was noted. For 66 % aircontent as disclosed in figure 14 a very stable time for achieving 66 % air content was achieved. No large differences are observed. But still for 75 % broke content the fastest time to reach 66 % air content was observed. The general formula for the surfactant were w+x+y+z = 20.



[0093] Halftimes for the foam made to broke content are disclosed in figure 18 for the surfactant of Example 5. As can be seen half time has a local maximum around 50 % broke content.

Claims

1. Method for producing a fibrous web, a paper or paper board comprising the steps of:

- providing a furnish comprising pulp,
- providing a surfactant to said furnish,
- mixing the furnish with the surfactant in order to achieve a foamed furnish,
- providing the foamed furnish to a wire that dewaters the foamed furnish in order to achieve the fibrous web,

paper or paper board,
characterized in that
the pulp of the furnish comprises a chemical pulp preferably to an amount of 25-100 % BDT, preferably 50-100 % BDT, more preferred 70-100 % BDT, more preferred 85-100 % of the pulp, most preferred essentially 100 % BDT of the total pulp content in BDT.

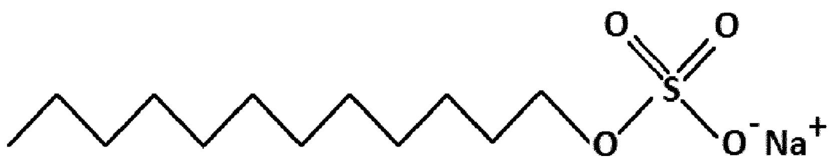
2. The method of any of the claims above, wherein further is comprised a step of added a sizing agent, preferably AKD or ASA or starch, or mixes of these.

3. The method according to any of the claims above, wherein further is comprised a step of adding a cationic polyelectrolyte, preferably the added cationic polyelectrolyte is starch.

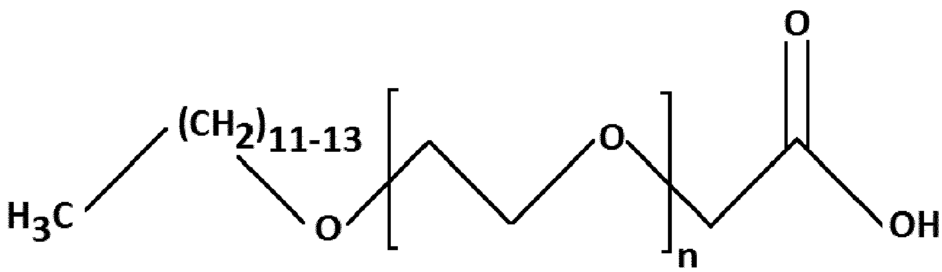
4. The method to any of the claims above, wherein further is comprised a step of adding alum, and/or PVAM and/or Bentonite, PAM, and or Silica.

5. The method to any of the claims above, wherein the pulp is prepared from soft wood or hard wood or a mixture of hardwood and softwood, and wherein said pulp preferably comprises broke from softwood and/or hard wood paper or board production, preferably said broke has pulp of a chemical pulp preferably to an amount of 25-100 % BDT, preferably 50-100 % BDT, more preferred 70-100 % BDT, more preferred 85-100 % of the pulp, most preferred essentially 100 % BDT of the broke pulp content.

6. The method according to any of the claims above, wherein the surfactant is anionic, preferably the surfactant is sodium dodecyl sulphate or glycolic acid ethoxylate lauryl ether, preferably the chemical formula of the anionic surfactant is



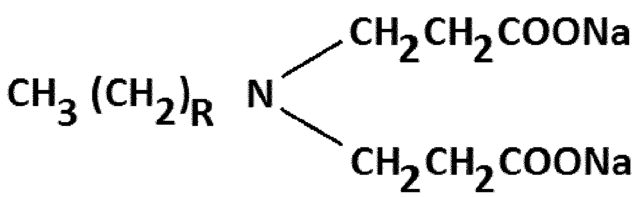
or



.

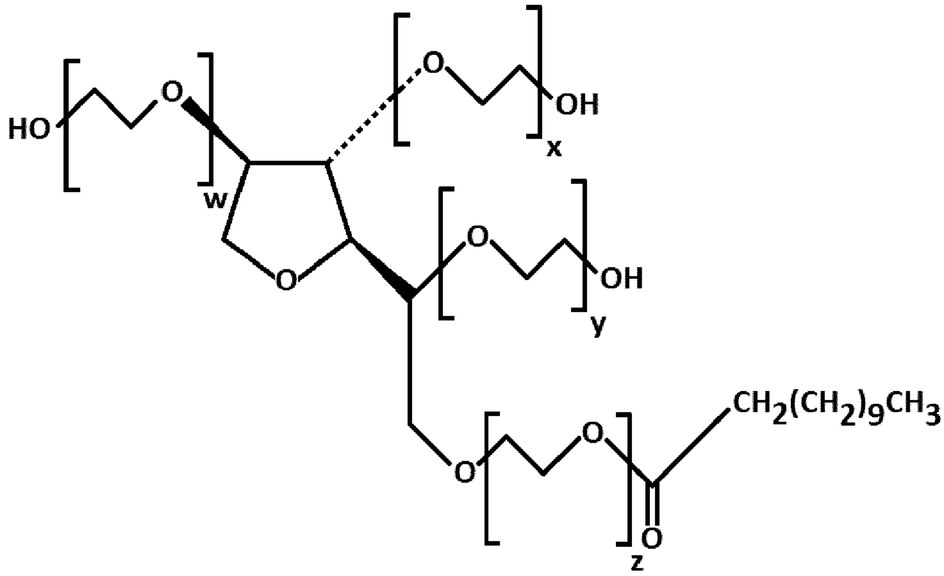
7. The method according to claim 6, wherein the surfactant is anionic and multi charged.

8. The method according to claim 6, wherein the surfactant is anionic with an ethoxylate chain, preferably with the following general formula:



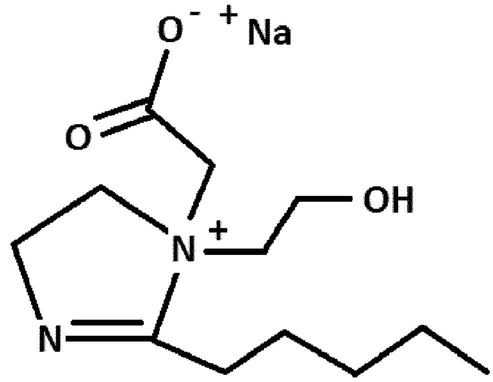
.

9. The method according to any of the claims above, wherein the surfactant is non-ionic, preferably with the general formula where w+x+y+z = 20.



.

10. The method according to any of the claims above, wherein the surfactant is amphoteric, preferably having the general formula



11. The method according to any of the claims above, wherein further provided are at least three head boxes to ad furnish to said wire in a consecutive order, for producing a paper or paper board product comprising at least three plies, wherein at least one of the head boxes is fed with the foamed furnish, and that head boxes that is not fed with the foamed furnish is/are fed with a separate furnish that is not foamed, preferably there is further comprised the step of providing the foamed furnish to at least the headbox that provides a middle ply, for making a middle ply of a three or more layered board product.

12. The method of claim 11, wherein there is further provided two more head boxes in order to produce a five ply product, wherein at least one of the inner three plies is made from the foamed furnish.

13. The method of any of the claims above wherein the provided furnish further has been bleached before use in the method, or wherein the provided furnish has not been bleached before use in the method.

14. The method of any of the claims above, wherein the pulp of the furnish further comprises broke in the amount of 20-90 % BDT more preferred 25-90 % BDT, even more preferred 40 %-90 % BDT, or even further preferred 45-80 % BDT or even further preferred 60-80% BDT or most preferred 72-77% BDT.

15. The method of any of the claims above, wherein the method does not comprise a step of adding a nano cellulose, such as micro fibrillated cellulose, and/or nanocrystalline cellulose, and/or cellulose nanofibres.

16. Paper or paper board product wherein, said product comprises at least three plies of fibrous webs, wherein at least one of the fibrous webs is produced according to the method of any of the claims above.

17. Paper or board product according to claim 16, wherein the furnish comprises virgin fibre pulp mixed with broke, preferably with broke in the amount of 20-90 % BDT more preferred 25-90 % BDT, even more preferred 40 %-90 % BDT, or even further preferred 45-80 % BDT or even further preferred 60-80% BDT or most preferred 72-77% BDT broke.

18. Paper or board product according to claim 16, wherein the broke has its origin from a paper or board product which fibre content comprises an amount of chemical pulp of 25-100 % BDT, preferably 50-100 % BDT, more preferred 70-100 % BDT, more preferred 85-100 % of the pulp, most preferred essentially 100 % BDT of the total fibre content in BDT.

19. Packaging box product, made from product of any of the claims 16-18.

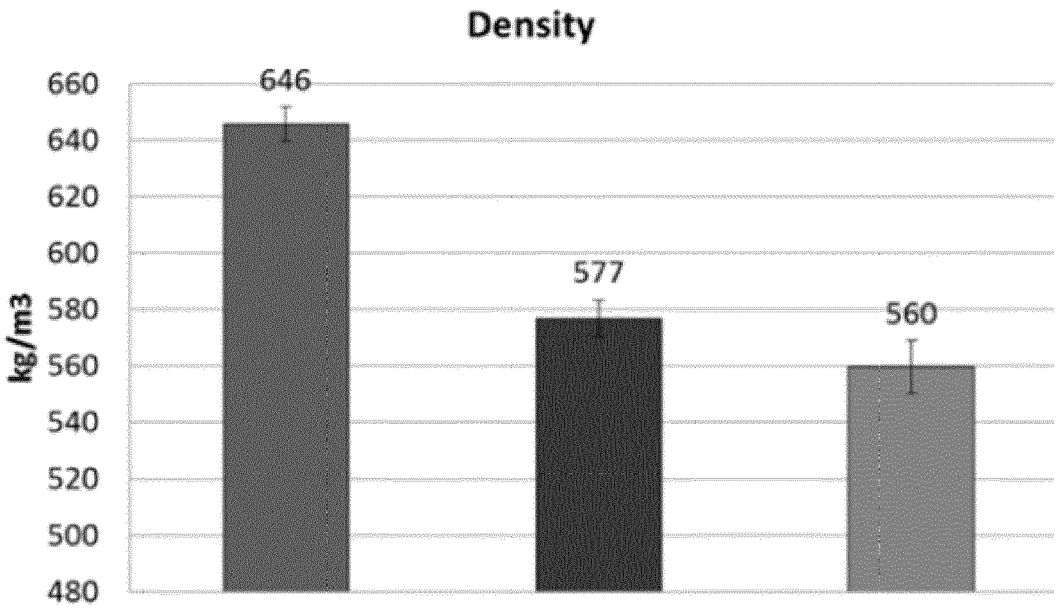

Density
660
640
620
600
580
560
540
520
500
480
kg/m3
646
577
560

Fig. 1

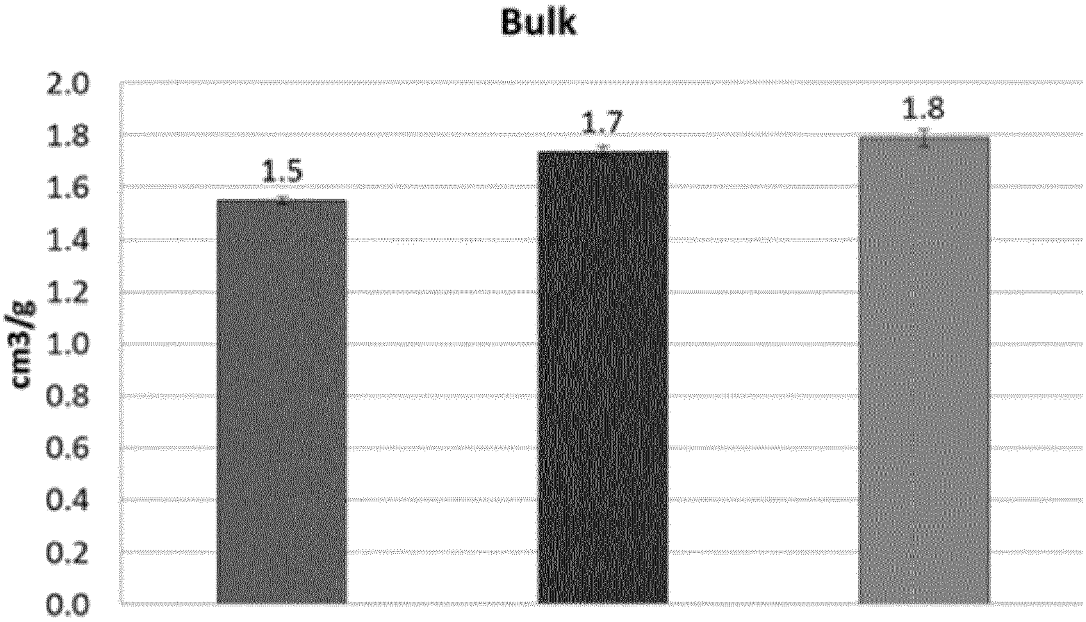

Bulk
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
cm3/g
1.5
1.7
1.8

Fig. 2

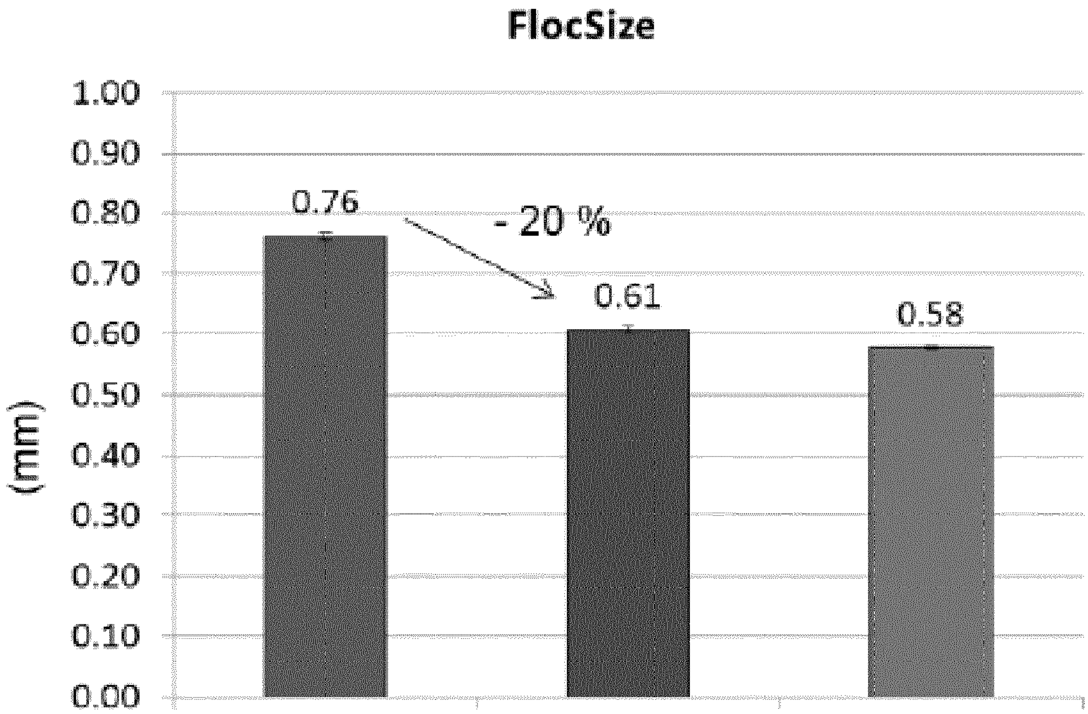

FlocSize
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
(mm)
0.76
- 20 %
0.61
0.58

Fig. 3

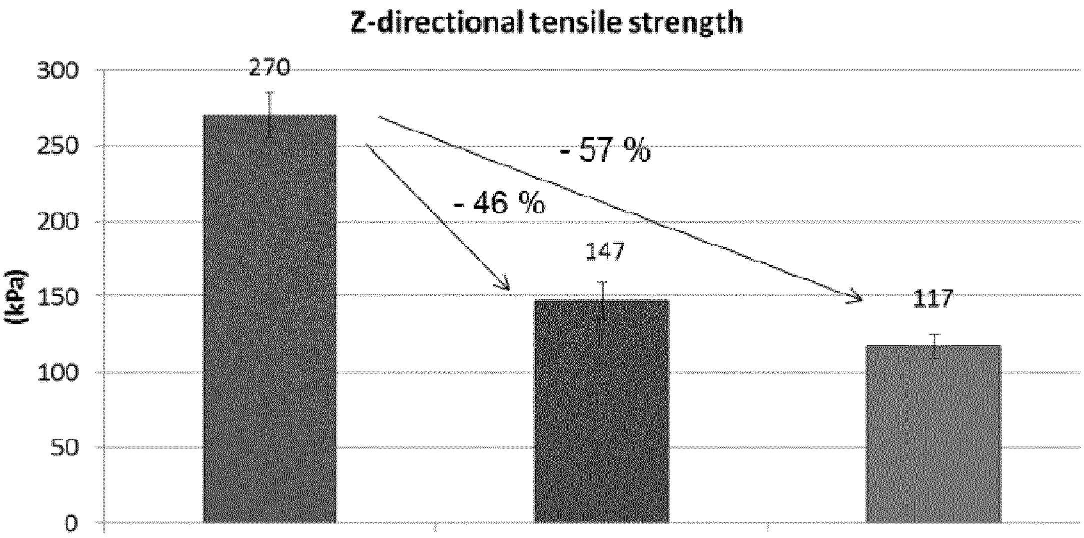

Z-directional tensile strength
300
250
200
150
100
50
0
(kPa)
270
147
117
- 57 %
- 46 %

Fig. 4

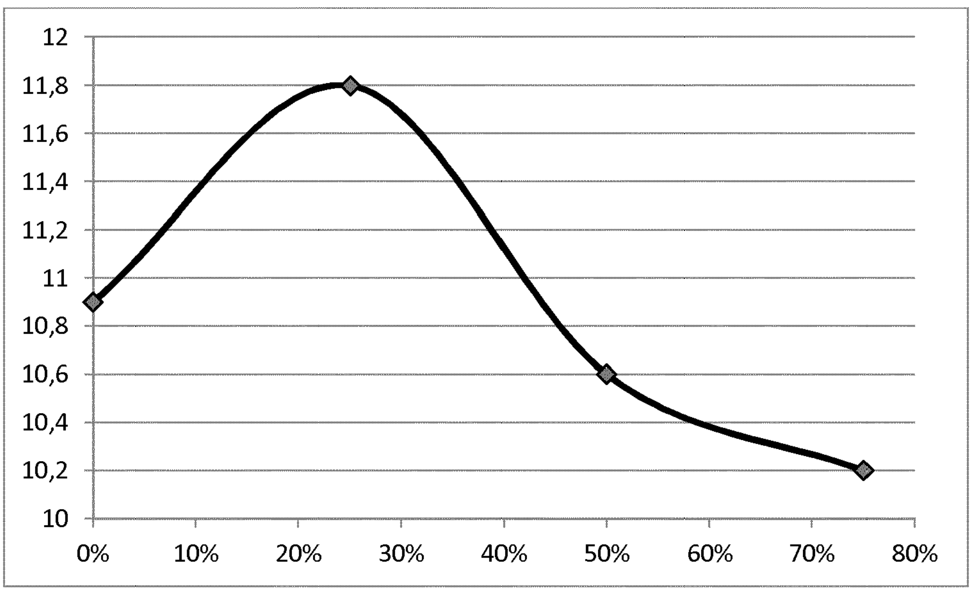

12
11,8
11,6
11,4
11,2
11
10,8
10,6
10,4
10,2
10
0%
10%
20%
30%
40%
50%
60%
70%
80%

Fig. 5

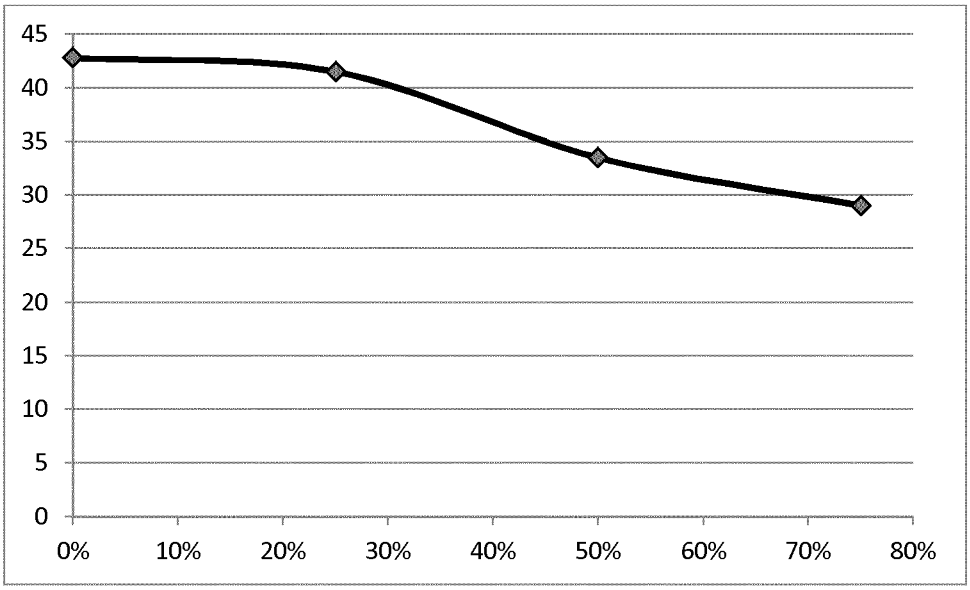

45
40
35
30
25
20
15
10
5
0
0%
10%
20%
30%
40%
50%
60%
70%
80%

Fig. 6

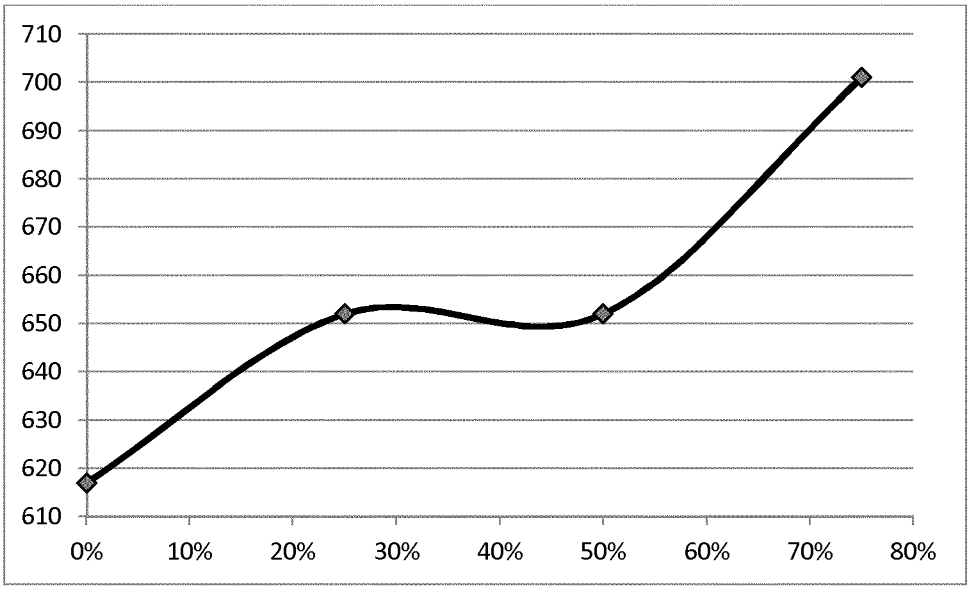

710
700
690
680
670
660
650
640
630
620
610
0%
10%
20%
30%
40%
50%
60%
70%
80%

Fig. 7

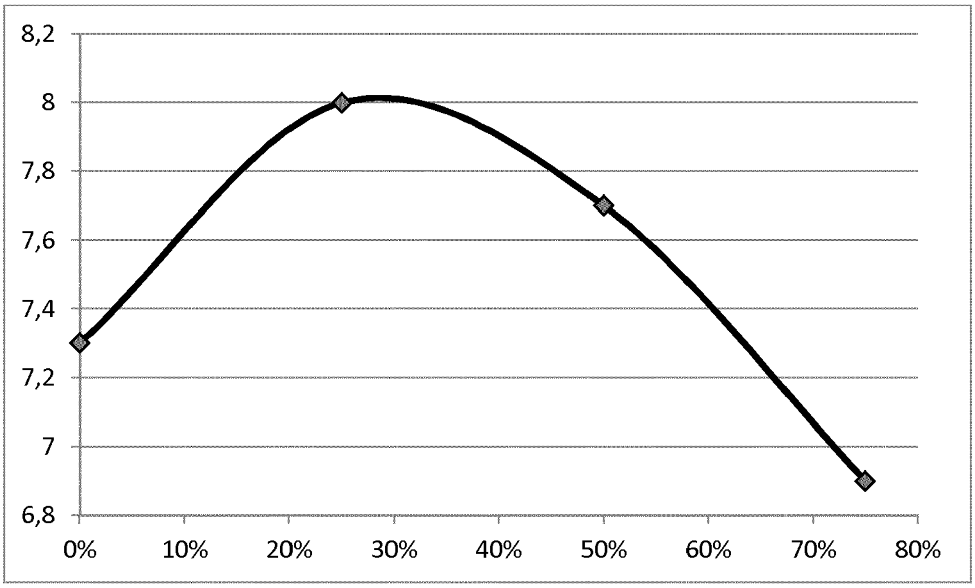

8,2
8
7,8
7,6
7,4
7,2
7
6,8
0%
10%
20%
30%
40%
50%
60%
70%
80%

Fig. 8

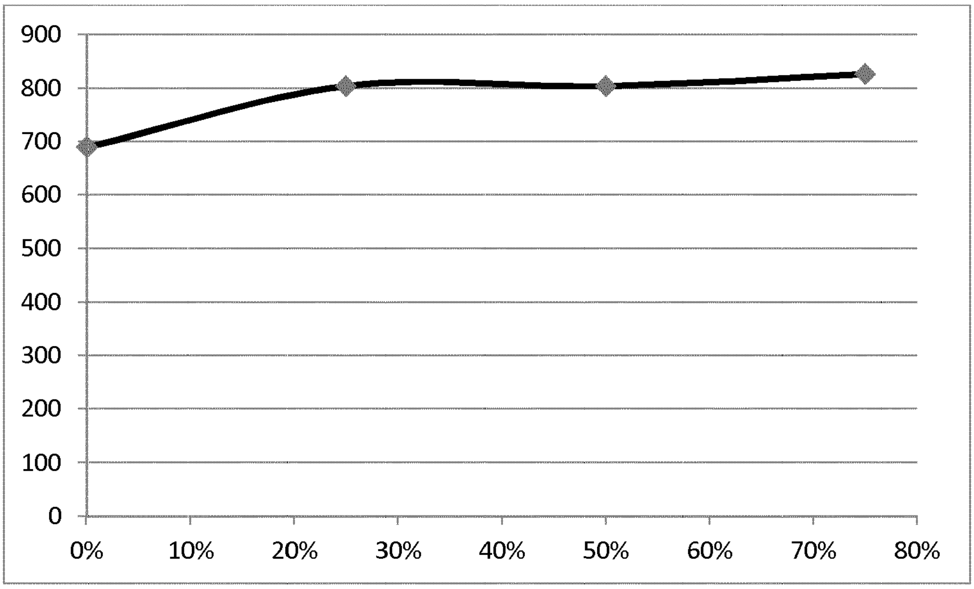

900
800
700
600
500
400
300
200
100
0
0%
10%
20%
30%
40%
50%
60%
70%
80%

Fig. 9

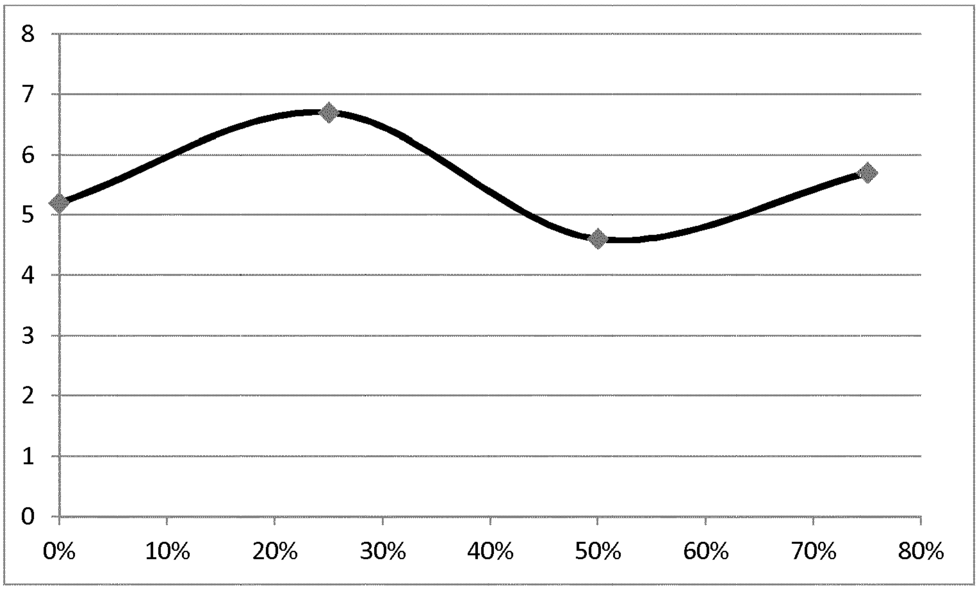

8
7
6
5
4
3
2
1
0
0%
10%
20%
30%
40%
50%
60%
70%
80%

Fig. 10

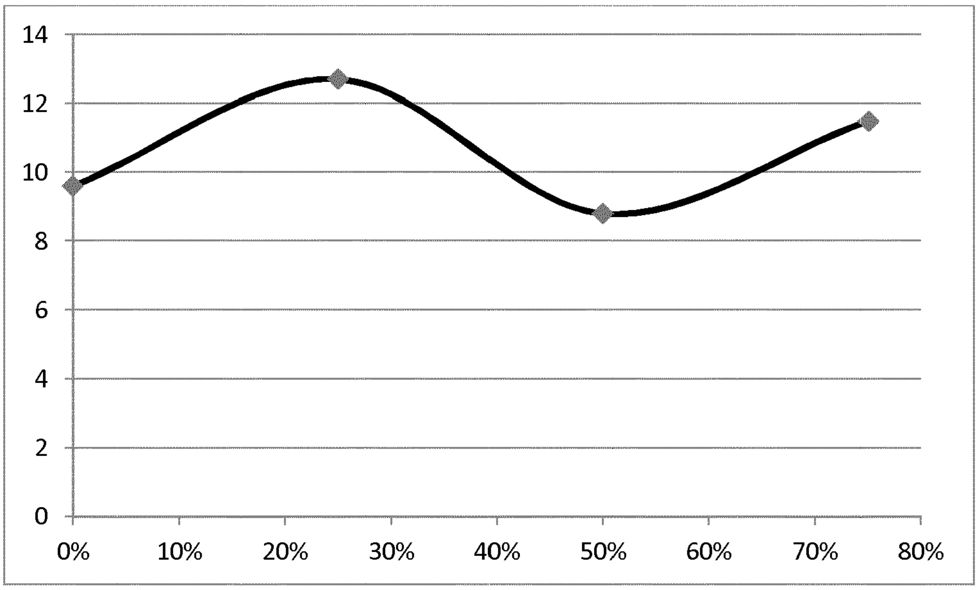

14
12
10
8
6
4
2
0
0%
10%
20%
30%
40%
50%
60%
70%
80%

Fig. 11

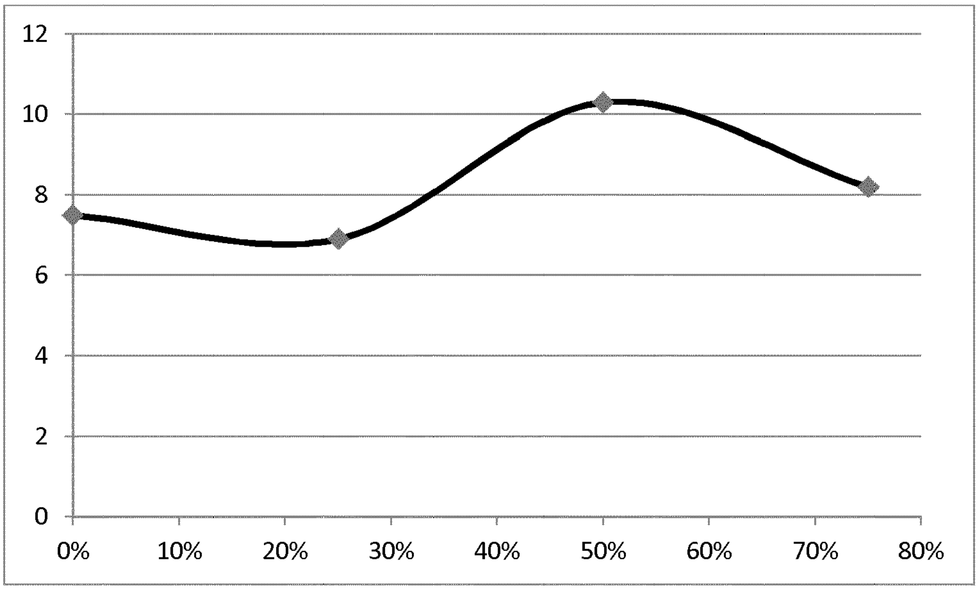

12
10
8
6
4
2
0
0%
10%
20%
30%
40%
50%
60%
70%
80%

Fig. 12

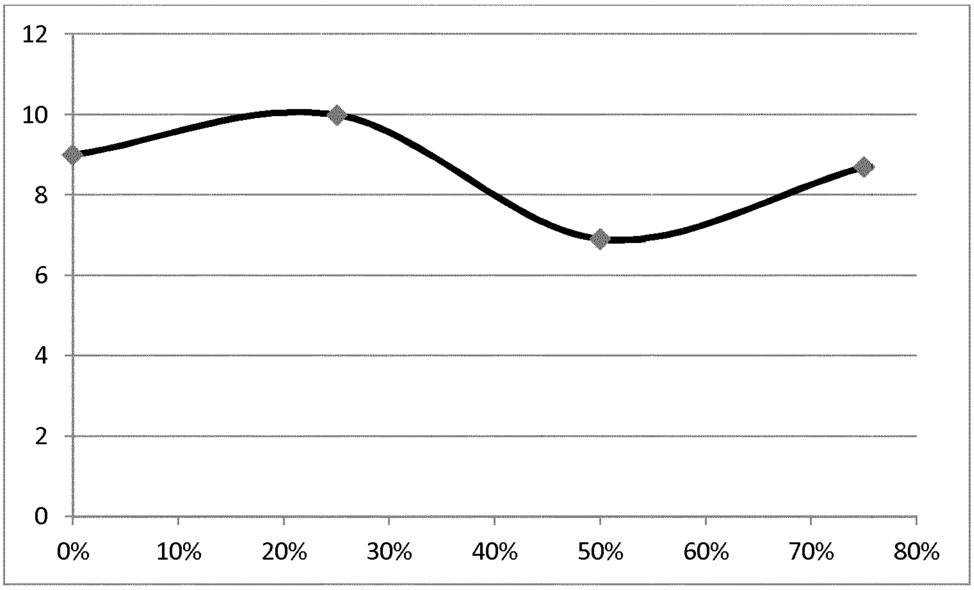

12
10
8
6
4
2
0
0%
10%
20%
30%
40%
50%
60%
70%
80%

Fig. 13

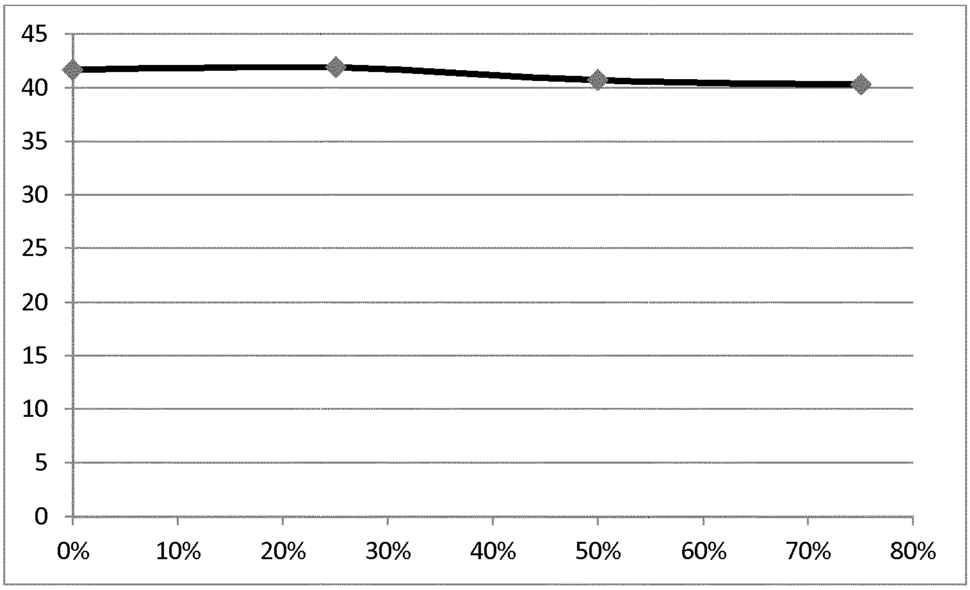

45
40
35
30
25
20
15
10
5
0
0%
10%
20%
30%
40%
50%
60%
70%
80%

Fig. 14

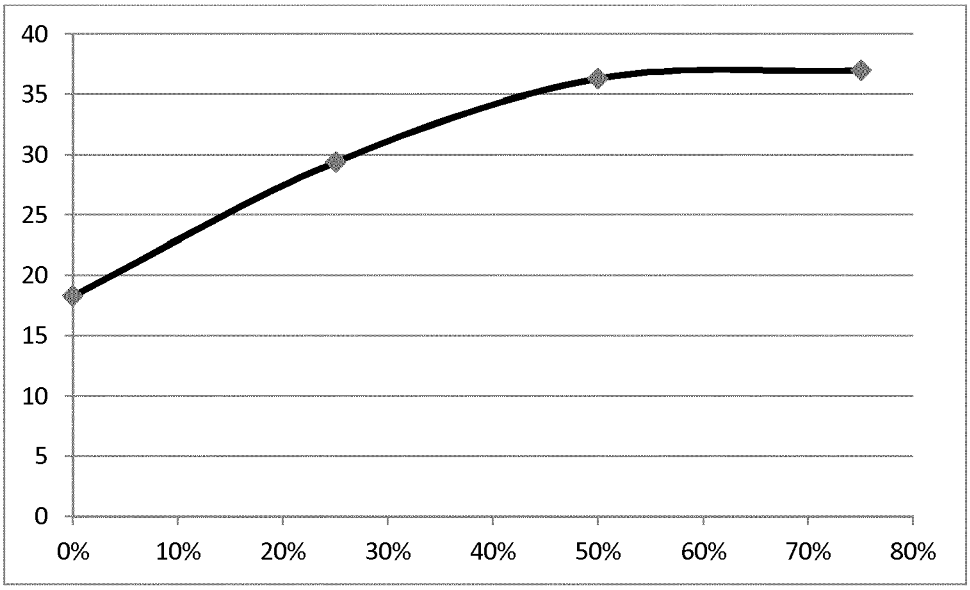

40
35
30
25
20
15
10
5
0
0%
10%
20%
30%
40%
50%
60%
70%
80%

Fig. 15

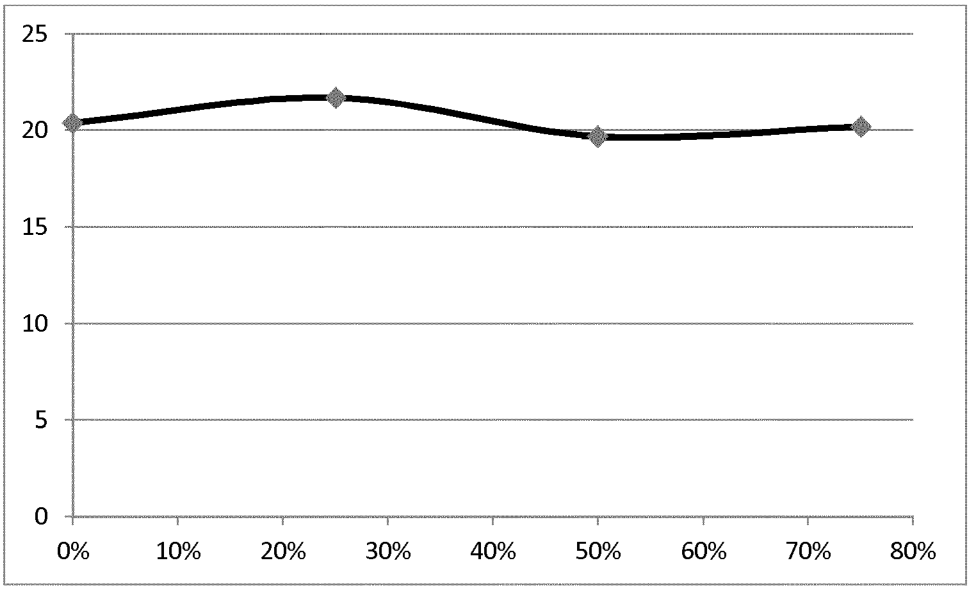

25
20
15
10
5
0
0%
10%
20%
30%
40%
50%
60%
70%
80%

Fig. 16

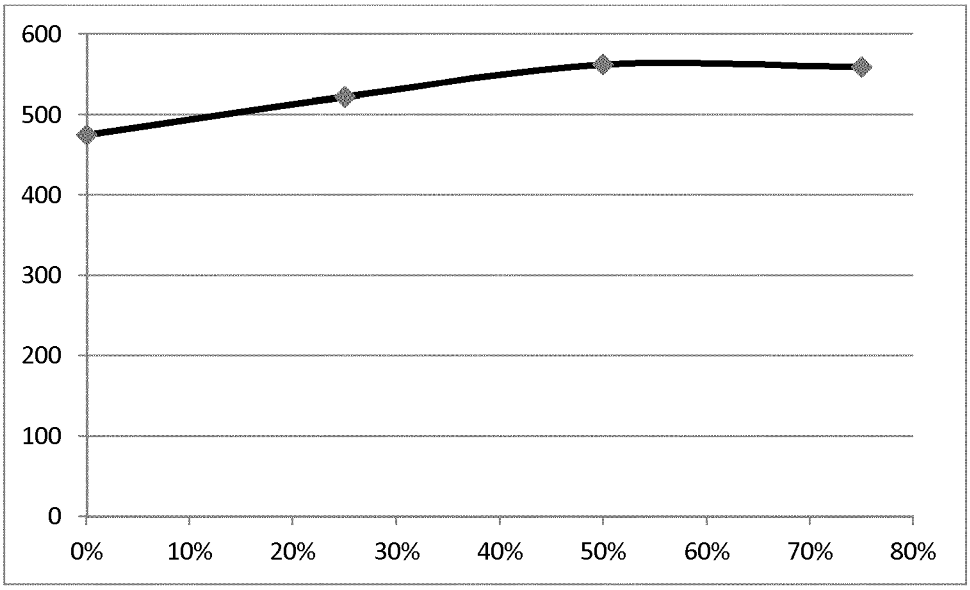

600
500
400
300
200
100
0
0%
10%
20%
30%
40%
50%
60%
70%
80%

Fig. 17

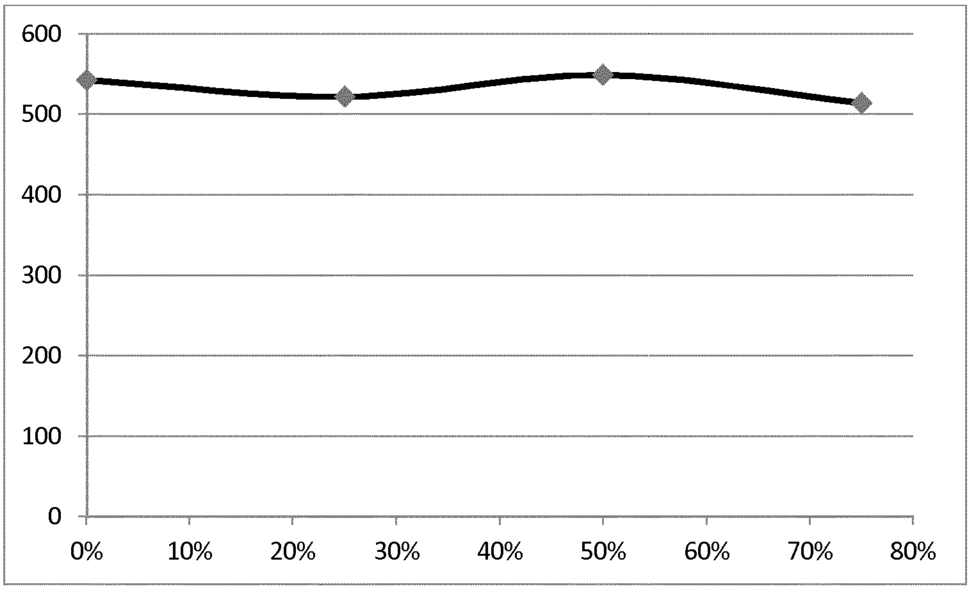

600
500
400
300
200
100
0
0%
10%
20%
30%
40%
50%
60%
70%
80%

Fig. 18

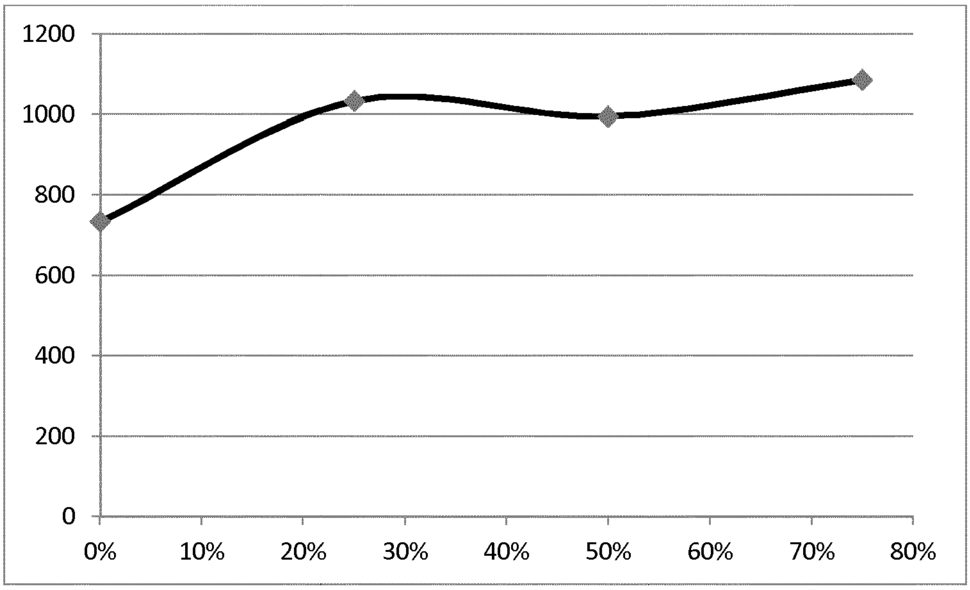

1200
1000
800
600
400
200
0
0%
10%
20%
30%
40%
50%
60%
70%
80%

Fig. 19

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 18 15 9525

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	WO 2013/160553 A1 (STORA ENSO OYJ [FI]) 31 October 2013 (2013-10-31) * claims 1-14 *	1-12, 14-19 13	INV. D21H17/16 D21H17/17 D21H17/28 D21H17/66 D21H21/16 D21H21/56
X Y	WO 2013/160564 A1 (STORA ENSO OYJ [FI]) 31 October 2013 (2013-10-31) * tables 1-25 *	1-12, 14-19 13	
X Y	WO 2015/173474 A1 (METSÄ BOARD OYJ [FI]) 19 November 2015 (2015-11-19) * claims 1-25 *	1-12, 14-19 13	
X Y	WO 2017/006216 A1 (STORA ENSO OYJ [FI]) 12 January 2017 (2017-01-12) * claims 1-11; example 1 *	1-12, 14-19 13	
X	WO 2018/011667 A1 (STORA ENSO OYJ [FI]) 18 January 2018 (2018-01-18) * claims 1-11 *	1,3	
Y	WO 2014/202841 A1 (METSÄ BOARD OYJ [FI]) 24 December 2014 (2014-12-24) * claims 1-20 *	13	TECHNICAL FIELDS SEARCHED (IPC) D21H
A	WO 2015/036930 A1 (STORA ENSO OYJ [FI]) 19 March 2015 (2015-03-19) * the whole document *	1-19	
A	WO 2012/006714 A1 (FPINNOVATIONS [CA]; FUJIAN AGRICULTURAL AND FORESTRY UNIVERSITY [CN];) 19 January 2012 (2012-01-19) * the whole document *	1-19	
A	US 4 571 360 A (BROWN RUSSELL L [US] ET AL) 18 February 1986 (1986-02-18) * the whole document *	1-19	

The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
Munich	7 June 2018	Karlsson, Lennart

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 18 15 9525

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

07-06-2018

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2013160553 A1	31-10-2013	BR 112014026792 A2	27-06-2017
		CA 2871554 A1	31-10-2013
		CN 104302834 A	21-01-2015
		EP 2841649 A1	04-03-2015
		ES 2617430 T3	19-06-2017
		FI 124235 B	15-05-2014
		JP 6307067 B2	04-04-2018
		JP 2015514884 A	21-05-2015
		PL 2841649 T3	30-06-2017
		PT 2841649 T	22-02-2017
		RU 2014146502 A	10-06-2016
		TW 201404972 A	01-02-2014
		US 2015114581 A1	30-04-2015
		UY 34768 A	29-11-2013
		WO 2013160553 A1	31-10-2013
WO 2013160564 A1	31-10-2013	BR 112014026790 A2	27-06-2017
		CA 2871555 A1	31-10-2013
		CN 104285006 A	14-01-2015
		EP 2841651 A1	04-03-2015
		ES 2652512 T3	02-02-2018
		FI 124556 B	15-10-2014
		JP 6310446 B2	11-04-2018
		JP 2015518096 A	25-06-2015
		PL 2841651 T3	28-02-2018
		RU 2014146501 A	20-06-2016
		US 2015096700 A1	09-04-2015
		US 2017335522 A1	23-11-2017
		WO 2013160564 A1	31-10-2013
WO 2015173474 A1	19-11-2015	CN 106715794 A	24-05-2017
		FI 126699 B	13-04-2017
		SE 1651631 A1	12-12-2016
		WO 2015173474 A1	19-11-2015
WO 2017006216 A1	12-01-2017	AU 2016288771 A1	21-12-2017
		CA 2988520 A1	12-01-2017
		CN 107709664 A	16-02-2018
		EP 3320141 A1	16-05-2018
		SE 1550985 A1	06-09-2016
		WO 2017006216 A1	12-01-2017
WO 2018011667 A1	18-01-2018	SE 1651026 A1	12-01-2018
		WO 2018011667 A1	18-01-2018
WO 2014202841 A1	24-12-2014	BR 112015031070 A2	25-07-2017

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 18 15 9525

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

07-06-2018

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		CA 2915969 A1	24-12-2014
		CN 105531422 A	27-04-2016
		EP 3011108 A1	27-04-2016
		FI 127368 B	30-04-2018
		RU 2015151714 A	26-07-2017
		US 2016186383 A1	30-06-2016
		WO 2014202841 A1	24-12-2014
WO 2015036930 A1	19-03-2015	BR 112016006857 A2	01-08-2017
		CN 104452417 A	25-03-2015
		CN 204343106 U	20-05-2015
		EP 3044371 A1	20-07-2016
		WO 2015036930 A1	19-03-2015
WO 2012006714 A1	19-01-2012	NONE	
US 4571360 A	18-02-1986	BR 8601296 A	02-12-1986
		CA 1263802 A	12-12-1989
		DE 3663159 D1	08-06-1989
		EP 0195459 A1	24-09-1986
		FI 861221 A	23-09-1986
		JP S61268735 A	28-11-1986
		NO 861128 A	23-09-1986
		US 4571360 A	18-02-1986

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82