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(54) **Process for the production of fibrous sheet structures using steam forming**

(57) The present invention relates to a process for the production of fibrous sheet structures, typically paper. Also within the ambit of the invention is a process for the production of fibrous sheet structures, which comprises steam forming and flash condensing as key for very low water content paper production.

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Description

[0001] The present invention relates to a process for the production of fibrous sheet structures, typically but not exclusively, paper. Also within the ambit of the invention is a process for the production of a fibrous sheet structures, which comprises steam forming and flash condensing as key for very low water content production of a fibrous sheet structures.

BACKGROUND OF THE INVENTION

[0002] In conventional paper making, 1 kg of a mixture of fibres, fillers and additives is diluted by 100 litres of water. Removal needs gravity, vacuum, pressing and steam. Particle boards are produced by dispersing wood particles in air and transfer them on a web. Subsequently the matter is heated and pressed.

SUMMARY OF THE INVENTION

[0003] It is one object of the invention to provide a process in which less water is needed.

[0004] The present invention, thus, provides a process for producing fibrous sheet structures, e.g. paper, comprising

a step (i) of introducing fibres into steam, and a step (ii) of, at least partially, condensing the steam by expanding it to allow forming of a paper sheet.

[0005] The very core of the application will be the new vapour-phase forming process for the production of fibrous sheet structures, e.g. paper and board. With this new technology in hand, fibrous webs can be produced with remarkably reduced water consumption, much less energy, higher materials efficiency, lower carbon emissions and can be made in smaller plants compared to conventional processes.

DETAILED DESCRIPTION OF THE INVENTION

[0006] Before the present invention is described in detail below, it is to be understood that this invention is not limited to the particular methodology, protocols and reagents described herein as these may vary. It is also to be understood that the terminology used herein is for the purpose of describing particular embodiments only, and is not intended to limit the scope of the present invention which will be limited only by the appended claims. Unless defined otherwise, all technical and scientific terms used herein have the same meanings as commonly understood by one of ordinary skill in the art.

[0007] Throughout this specification and the claims which follow, unless the context requires otherwise, the word "comprise", and variations such as "comprises" and "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps. In the following passages different as-

pects of the invention are defined in more detail. Each aspect so defined may be combined with any other aspect or aspects unless clearly indicated to the contrary. In particular, any feature indicated as being preferred or advantageous may be combined with any other feature or features indicated as being preferred or advantageous.

[0008] As used herein, a "fibrous sheet structure" is encompassing any structure that contains or encompasses fibres to fabricate materials, preferably characterized by the x-y dimension being more than 1000 times, typically 10000 times larger than the z- dimension and/or a thickness of less than 5, typically less than 1 mm.

[0009] As used herein "high consistency" defines that the water content of the matter used is 0 to 50 wt.%, preferably 0,5 to 40 wt.%, more preferably 1 to 30 wt.%, typically lower than 30%.

[0010] As used herein, a "cellulosic fibre" may be any fibre that comprises, consists of, includes, contains or encompasses cellulose.

[0011] As used herein, a "fibre" includes any other mineral or organic compound as well as any chemical substance, which is encompassed with the term "fibre". Thus the definition covers all current and future mixtures of fibres and other matter to produce fibrous sheet structures, typically paper.

[0012] Some documents are cited throughout the text of this specification. Each of the documents cited herein (including all patents, patent applications, scientific publications, manufacturer's specifications, instructions, DIN norms etc.), whether *supra* or *infra*, are hereby incorporated by reference in their entirety. Nothing herein is to be construed as an admission that the invention is not entitled to antedate such disclosure by virtue of prior invention.

[0013] As mentioned, the invention provides a process for producing fibrous sheet structures comprising a step (i) of introducing or dispersing fibres into steam, and a step (ii) of condensing the steam by expanding it to allow forming of a fibrous sheet structures. Specifically, this process uses steam instead of water in the formation phase and condensed into a near to dry form. The whole temperature profile of the process will be reversed. Practically, this revolutionary concept skips the dilution of fibres in water, and thus comes near the old papermaker's dream of waterless paper production but still relies on nature's gift of bond formation. The fibres are typically fibres at high consistency.

Forming section

[0014] The fibres may be introduced in step (i) via a blowline, e.g. similar to the ones used in MDF or non-wovens production, into steam, preferably into highly turbulent steam. The steam in step (i) may have a temperature of 120 to 220°C, preferably 140 to 200°C and more preferably 150 to 180°C. Preferably, the fibres are introduced in step (i) together with at least one additive, e.g.

selected from fillers, processing aids, reinforcing agents, modifiers, coatings, or any combination thereof.

[0015] This steam carries the moist fibres into the forming zone, where the saturated steam expands and releases the latent heat in condensing and the necessary moisture is released to provide a basis for natural hydration and bond formation (conventional hydrogen bonding) between the fibres. During condensation, the volume of the steam shrinks to a fraction of the original while negative pressure is formed that forces the fibres and all possible additives to form a tight web. The water content may be no more than 30% after the wire. There may be no water runoff. Due to high gas velocities the forming section is very short.

[0016] Steam forming can accommodate all kind of fibres. The fibres may be selected from cellulosic fibres, hydrophilic fibers, hydrophobic fibers, chemically-pulped pulp fibres, mechanically pulped fibres, thermo-mechanically pulped fibres, fibers from bale chemical pulp, recycled fibres, or any combination thereof but is not limited to this type of fibres.

[0017] Preferably, the fibres are pre-dried before step (i), preferably dried to comprise from 0 to 30 wt.% water, more preferably from 0,5 to 40 wt.% water, more preferably from 1 to 25 wt.%. In particular, the whole process is operating at a very high dry content of at least 70%. The whole temperature profile of the paper making process is reversed as the maximum temperature is hit right in the beginning of the process. Expanding steam leads to high dilution and thus supports forming of the paper sheet. Drying takes place at or above the atmospheric boiling point taking advantage of the gradient.

[0018] Further, the process may comprise a step (iii) of drying the fibrous sheet structures, which may be carried out by the application of pressure and/or heat.

[0019] When applied, the process reduces fossil CO₂ emissions by 50% and results in a 20% saving of primary energy. Furthermore, the new technology allows smaller productions units with a 40% lower investment per capacity unit and a very low environmental impact and no effluent emissions. In addition the process can be used to produce a full range of products replacing plastics.

[0020] There are no limitations in adding coatings afterwards online or offline in the process to further enhance optical properties and printability of the products in a proven way.

[0021] Significant savings to the steam forming and dry condensed fibrous sheet structures making concept are: a.) at least -50% in energy consumption for drying: a significantly smaller amount of water is to be evaporated in the dryer section: less than 360 instead of 900 1/t dry product -> (-60%). In addition, the new pressing and drying starts at or above boiling point, uses the condensing effect and will thus need very little heating. Major use of steam will be the driving steam the fibres are to be fluidized in. b. very small amount of fresh water used and no effluent treatment plant needed.

[0022] Various modifications and variations of the in-

vention will be apparent to those skilled in the art without departing from the scope of the invention. Although the invention has been described in connection with specific preferred embodiments, it should be understood that the invention as claimed should not be unduly limited to such specific embodiments. Indeed, various modifications of the described modes for carrying out the invention which are obvious to those skilled in the relevant fields are intended to be covered by the present invention.

[0023] The following example is merely illustrative of the present invention and should not be construed to limit the scope of the invention as indicated by the appended claims in any way.

EXAMPLES

Example:

[0024] In conventional paper making, 1 kg of fibres is diluted by 100 litres of water. Removal needs gravity, vacuum, pressing and steam.

[0025] If 1 kg of fibres are suspended in 100 litres of water vapour, the mass of water is only 6 % on the mass of fibres. This means less than 0.1 litres of water per 1 kg of fibre. This amount of water is easily absorbed and dried out of the paper sheet.

Claims

1. A process for producing fibrous sheet structures comprising
a step (i) of introducing fibres into steam, and
a step (ii) of condensing the steam by expanding it to allow forming of a paper sheet.
2. The process of claim 1, wherein the fibres before being suspended in the steam are at high consistency.
3. The process according to claim 1 or 2, wherein the fibres are introduced in step (i) via a blowline.
4. The process according to any of the preceding claims, wherein the steam in step (i) has a temperature of 120 to 220°C, preferably 140 to 200°C and more preferably 150 to 180°C.
5. The process according to any of the preceding claims, wherein the fibres are introduced in step (i) together with at least one additive.
6. The process according to claim 5, wherein the at least one additive is selected from fillers, processing aids, reinforcing agents, modifiers, coatings, or any combination thereof.
7. The process according to any of the preceding

claims, wherein the fibers are cellulosic fibres, and/or wherein the fibres are selected from hydrophilic fibers, hydrophobic fibers, chemically-pulped pulp fibres, mechanically pulped fibres, thermo-mechanically pulped fibres, fibers from bale chemical pulb, recycled fibres, or any combination thereof. 5

8. The process according to any of the preceding claims, wherein said fibres are pre-dried before step (i), preferably dried to comprise from 0 to 30 wt.% water, more preferably from 1 to 40 wt.% water, more preferably from 1 to 25 wt.%. 10
9. The process according to any of the preceding claims, wherein said fibres are prepared at high consistency before step (i), preferably at 0 to 30 wt.% water, more preferably at 0,5 to 40 wt.% water, more preferably at 1 to 25 wt.% water. 15
10. The process according to any of the preceding claims, wherein the process comprises a further step (iii) of drying the fibrous sheet structures. 20
11. The process according to claim 9, wherein step (iii) is carried out by drying. 25

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EUROPEAN SEARCH REPORT

Application Number
EP 13 19 4305

DOCUMENTS CONSIDERED TO BE RELEVANT			
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			TECHNICAL FIELDS SEARCHED (IPC)
			D21H D21F D21C
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 26 March 2014	Examiner Ponsaud, Philippe
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	

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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The members are as contained in the European Patent Office EDP file on
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82