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(19)

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(54) FIBRE-CONTAINING PRODUCTS IN SHEET FORM

(71) We IMPERIAL CHEMICAL INDUSTRIES LIMITED, Imperial Chemical House, Millbank, London SW1P 3JF a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

The present invention relates to fibre-containing products or compositions in sheet form, particularly paper and paper-like products or compositions, containing formaldehyde-resin fibres, in particular urea-formaldehyde fibres, which may be crimped or straight. As used hereinafter, the phrase "crimped fibres" is used to define fibres, examination of which reveals that the majority of the fibres have at least one significant and permanent deviation from linearity along their length, the term "significant deviation" meaning a deviation of at least 20°. Also as used hereinafter, the phrase "straight fibres" is used to define fibres, examination of which reveals that the majority of the fibres do not have any significant and permanent deviation from linearity along their length, the term "significant deviation" meaning a deviation of at least 20°.

Many materials in sheet form contain natural or synthetic fibres. Such fibre-containing sheet materials include textiles, insulating materials and, in particular, paper which, as is well known in the art, is typically made from cellulose pulp (comprising, for example, chemically pulped and disintegrated wood, mechanically ground wood, cotton linters, and mechanically pulped rags). We have now found that the fibres contained in such fibre-containing sheet materials can advantageously be partially replaced by formaldehyde-resin fibres, in particular urea formaldehyde fibres.

Formaldehyde resins, particularly amino formaldehyde resins are well known as bonding materials for wood, and also in paper as binding or wet strength additives (urea or melamine-formaldehyde resins, or chemical modifications thereof are used). They are also used to impregnate cellulose papers, e.g. for the production of decorative laminates. Crushed urea-formaldehyde foam has also been used as a filler for paper making (for example in US Patent 3 322 697, to the Scott Paper Company, and in West German Patent 1 241 251 to BASF). All uses of amino formaldehyde resin products in paper hitherto have thus been of a binding or filling nature. We have found that fibres of formaldehyde resins, as herein described, can have surprising benefits in improving, inter alia, the bulk, tear strength, burst strength, tensile strength, drainage times, printability and processing of papers as described hereinafter.

The preferred fibres for use in the present invention are essentially unbranched and either straight or crimped. For applications involving use with cellulose fibres, it is desirable, for maxiumum strength, that only minor amounts of crimping be present. The fibres may be of circular or irregular cross-section. Advantageously, for paper making, fibres of elliptical cross-section may be used to facilitate the laydown of the fibre in the paper sheet. Such fibres can be usefully made by centrifugal spinning, as described in our British Patent Application No. 10405/77. (Serial No. 1 573 116)

The mean diameter of the fibres is from 1 μ to 30 μ (for irregular fibres, average diameters are taken). More particularly, the average is between 2 μ and 20 μ, particularly between 5 μ and 15 μ. There may be present, advantageously, a range of fibre diameters from 1 μ to 30 μ to enable the formation of a sheet of more uniform density. Fibres with a range of diameters can be prepared, conveniently by centrifugal spinning as described in our said co-pending application.

For some applications, particularly when smooth papers are required, it may be desirable to ensure that there is an insignificant number of fibres of diameter above 25 μ.

The fibres used in the present invention, whether straight or crimped, characteristically also have an average length of at least 1 mm. It is a surprising feature of the invention that long fibres (⩾ 2 mm) can be incorporated into papers without causing problems of premature flocculation in the papermaking process and hence uneven formation of the sheet. It may therefore be desirable to use fibres that are as long as the papermaking process can accommodate. The practical upper limit to the length may therefore be, for this reason, in the range 5 – 10 mm. A minor degree of branching of the fibres may be present (due to fusion during production of the fibres), but preferably the fibres are essentially nonbranched.

In the case of straight fibres, their linearity is preferably such that they can be compacted to a reasonably dense paper form. Crimped fibres tend to be bulky, and characteristically their bulk density is low.

The fibres for use in the present invention are conveniently prepared from a formaldehyde resin, typically a UF resin of F:U molar ratio 1.2 to 3.0, preferably 1.5 to 2.5. Some or all of the urea can be replaced by (for example) melamine; minor amounts of phenol, resorcinol, cresol, may be added. A proportion of the formaldehyde may be replaced by other aldehydes, for example acetaldehyde. The resins are conveniently prepared by aqueous condensation by any of the conventional methods already well known to those skilled in the art. The resin may be converted into fibres using the aqueous resin at a suitable concentration or by handling the dried partially-condensed resin as a melt.

The resin-forming composition is formed, while still flowable, into fibres. This can be suitably done by conventional spinning of a viscous resin syrup into hot air ("dry-spinning") or into an acid bath ("wet-spinning"). Alternatively it can be formed by passing a fine stream or series of drops into a flowing resin-gelling liquid or by gas-fibrillation (in particular air-fibrillation) by means of a co-current or transverse gas stream as described in our co-pending British Patent Application No. 51199/76 (Serial No. 1 573 114) (corresponding to USSN 857972). As a further alternative it can be spun by tack-spinning, by pulling a fiberisable material between two surfaces to which it adheres and subsequently severing the fibres from one or both of the surfaces. For example, as described in UK patent 1141207, the resin may be moved into contact with a pair of belt surfaces so as to deposit it therebetween, whereafter the surfaces of the belts are moved apart to form fibres and stretch them, and the fibres are detached and collected. In another tack-spinning process fiberisable material is interposed between a porous surface and a second surface, the surfaces are caused to diverge so as to string fibres between them, the fibres are stabilised or solidified at least in part by fluid directed into or through the fibre-forming area from the opposite side of the porous surface to that on which the fibres are formed, and the fibres are separated at least from the second surface. Conveniently, suitable fibres can be prepared by a centrifugal spinning process as described in our co-pending UK Patent Application No. 10405/77. (Serial No. 1 573 116) In these instances, generally straight fibres are produced.

Curing of the fibres to render them insoluble in cold water can be achieved by adding an acid (e.g. formic or sulphuric acid) or a salt of an acid, preferably an ammonium salt, to the resin, prior to forming the fibres, and/or by heating the fibres after their formation.

To form crimped fibres, the fibres can be only partially-cured after formation; they are then subjected to a crimping or twisting step, and thereafter curing, to render them insoluble in cold water, is completed.

The fibres may need to be reduced in length to that required for papermaking. This can be achieved by cutting, passing through rollers, milling, or by wet disintegration as is well-known in the paper industry. The fibres should be adequately cured and rendered insoluble in cold water (as described above) before being used for this purpose.

Pigments, dyes, brightening agents, and/or fillers, may be incorporated into the resin before forming the fibres.

The present invention accordingly provides a paper product, including a first fibrous component comprising 5% to 70% by weight of formaldehyde-resin fibres which are insoluble in cold water, which have an average length, weighted by the length of the fibres, of at least 1 mm., which have an average strength ⩾ 50 MNm^{-2} (≡ 33 Nm/g), and which have a mean diameter between 1 μ and 30 μ, and a second fibrous component comprising 30% to 95% by weight of cellulose pulp which comprises a mechanical pulp of freeness no more than 120 ml. CSF (Canadian Standard Freeness) and/or a tensile strength measured on a standard hand sheet of at least 24 Nm/g, and/or a chemical pulp of freeness no more than 400 ml. CSF and/or a tensile strength measured on a standard hand sheet of not less than half the zero span tensile strength.

The above-mentioned properties of the cellulose pulp can be achieved by known methods, for example by beating and/or by treatment with a bonding agent.

Preferably the mechanical pulp has a freeness not greater than 80 ml. CSF and/or a tensile strength measured on a standard hand sheet of at least 28 Nm/g.

Preferably the chemical pulp has a freeness of not more than 300 ml. CSF and/or a tensile strength measured on a standard hand sheet of at least 60% of the zero span tensile strength.

The second fibrous component may contain or consist of recycled fibres of the cellulose pulp as hereinabove defined.

Preferably the formaldehyde resin fibres are UF fibres. Preferably the fibres have a mean diameter between 2 μ and 20 μ, more particularly between 5 μ and 15 μ. The fibres may be produced by methods as hereinafter described, but preferably they are produced by centrifugal spinning since this tends to produce fibres of elliptical cross-section containing less shot within the desired diameter than other methods.

Whereas the bulk or density of paper containing cellulose pulp can be varied by conventional means (e.g. by using pulp of a limited degree of beating or refining) such variations are, for a given pulp combination, limited in scope, and where significant increases in bulk are desired for reasons of economy this is often accompanied by unacceptable decreases in mechanical or barrier properties, similarly, for cellulose furnishes, improvements in the rates of drainage in papermaking can only be accompanied by changing beating conditions and an adverse change in properties.

We have now found that certain combinations, involving urea formaldehyde fibres, can provide a surprisingly advantageous combination of high bulk, rapid drainage and drying, with good mechanical properties and acceptable barrier properties. Such combinations are particularly useful for, for example, printing paper, where light weight paper of acceptable or improved capacity and mechanical properties can be obtained, or in board or other packaging applications where the improved stiffness and rapid drainage and drying of the stock are of great advantage.

In paper containing short fibre pulp, particularly groundwood (i.e. mechanical pulp), the combinations also show improved tear strengths over the groundwood alone, and much easier drainage than is usually possible with mechanical pulp furnishes.

In combinations with high grade chemical pulps, significant improvements in bulk and advantages in stiffness and printing properties are obtained by this invention.

The compositions involve the use of 5 – 70% UF fibres. In order to achieve the described benefits it is necessary for the fibres to be above a certain length, namely 1 mm, preferably above 2 mm. Longer fibres achieve higher tear strengths; it is possible to use mixtures containing long fibres because we have found, surprisingly, that such long fibres can be incorporated into paper without the problems of uneven formation normally associated with the use of such fibres. The mean diameter of the fibres should be in the range 1 – 30 μ, preferably 2 – 20 μ. It is particularly desirable to avoid the use of fibres above 30 μ diameter as in some applications the surface of the paper may become unacceptably rough.

The average strength of the fibres must be above 50 MNm^{-2} (≡ 33Nm/g) when measured on a tensile test of single or grouped fibres. Since the strength and tear properties of the compositions is dependent to a degree on the strength of the fibres, it is preferable for the average strength to be at least 100 MNm^{-2} (≡ 67 Nm/g). Surprisingly, though, excellent mechanical properties can be obtained with UF fibres; the UF fibres are not birefringent, unlike cellulose or other fibres (e.g. nylon or terylene) which have been added to paper to improve tear strengths.

The UF fibres are preferably straight as defined above. However for paper of extra high bulk, the fibres can be crimped.

The rest of the fibrous furnish is a cellulose pulp treated so that it is well bonded. The definition of "well bonded" depends upon the type of cellulose pulp in question; for a mechanical pulp it can be defined as occurring when the pulp has been beaten or refined to a freeness of 100 ml. CSF or less. For chemical pulp (e.g. pulp extracted by the sulphate or sulphite processes) the freeness for good bonding can be higher, and our definition of well bonded is that degree of bonding (e.g. as achieved by beating or refining) which achieves a tensile strength in a standard handsheet of at least half the zero-span tensile strength. The strength tests are made according to the appropriate TAPPI procedures. In many cases, it is preferable to achieve the required levels of bonding not by beating or refining but by adding bonding agents – for example starches and modified starches, polymer latices, water soluble polymers (e.g. poly (ethylene imine), poly(acrylamide), poly(vinyl pyrrolidone), particularly when treated to be cationic in water). These bonding agents can be added with the fibrous furnish or in a subsequent inpregnation or coating stage. Particularly favoured are cationic bonding agents added with the fibres – those mentioned above, cationic starch or urea formaldehyde, or melamine-formaldehyde resins, as conventionally used to achieve increases in wet strength.

Such levels of bonding are well known to lead to high tensile strengths, but reduced tear strengths and low bulk paper. The addition of urea-formaldehyde fibres in the manner described leads to improvement in bulk and tear strength and the maintenance of excellent tensile properties.

Paper made according to the invention may be filled (for example with clay, TiO_2 or other pigments), coated or calendered. Calendering will naturally reduce the thickness of the paper, and will usually improve mechanical properties, but in the case of the present invention bulkier papers than those possible with a conventional furnish are achieved.

EXAMPLE 1

To 100 parts by weight of a UF resin solution ("Aerolite 300", Registered Trade Mark, from Ciba-Geigy), were added 0.25 parts by weight of ammonium sulphate, and enough water to adjust the viscosity to about 20 poise at 23°C. ("Aerolite 300" is an aqueous U/F resin prepared by condensing a mixture of urea and formaldehyde in a F:U molar ratio of about 1.95:1, followed by concentration to a solids content of about 65% by weight. It has a viscosity, depending upon its age, of about 40 to 200 poise at room temperature, and a water tolerance of about 180%). Fibres were prepared from this solution by air fibrillation; the resin was passed through an orifice downwards at a rate of about 12g/minute in the form of a continuous thread. The thread was impacted with an air jet (air rate ~ 300 standard cubic feet per hour at pressure to the jet of 30 psig). Fibres were formed in the turbulent airstream and blown into a drum containing air heated to 50°C, where they were collected and dried. The fibres were cured by heating at 120°C for 4 hours which rendered them insoluble in cold water. After curing, the bulk density of the fibres, uncompacted, was about 0.1 g cm^{-3}. The fibres were disintegrated in a standard laboratory pulp disintegrator in water (consistency 0.3%) to a length of about 2 mm. At this point the fibres were screened to remove any large particulate species. The fibres were about 12 μ in average diameter.

Laboratory test papers were made using standard pulp evaluation equipment from this suspension of fibres and a similar suspension of mechanical pulp. Two papers were prepared, one containing 100% mechanical pulp (A) and one containing 80% by weight mechanical pulp and 20% by weight UF fibres (B).

The drainage time on paper A was longer than on paper B, and the drained paper A held more water than B. When compacted and dried in a standard manner, the following properties were measured:—

	A	B
Burst Index (KP/gm^{-2})	0.90	0.90
Stretch, %	1.5	1.7
Bulk, $cm^3 g^{-1}$	2.3	2.7

Preparation of Hand-sheets

These were prepared using the British Standard apparatus, and this and the methods used are described fully in the literature, for example in "A Laboratory Handbook of Pulp and Paper Manufacture" by J Grant (Arnold, 1942), p 78 – 82; some changes to the method were made, however – the disintegration of fibres was performed for 50,000 revolutions at 0.3% consistency and cellulose pulp, when used, was pre-beaten in a small Valley beater.

EXAMPLE 2

A sample of bleached pine sulphate pulp was beaten until a standard handsheet prepared from the pulp had a tensile strength of 77 Nm/g and a zero span tensile strength of 134 Nm/g. Paper samples were prepared from this and from disintegrated urea formaldehyde fibres.

The urea formaldehyde fibre was prepared from the resin used in example 1, and was fibrillated by centrifugal spinning (as described in our co-pending British Patent Application No. 10405/77) (Serial No. 1 573 116) using the following conditions:—

Cup diameter 7.5 cm, with 24 holes, each 3 mm diameter, in the periphery of the cup; rotation speed 4500 rpm; resin flow rate 78g/min, with a viscosity of 35 poise at 23°C. The fibre was spun into an atmosphere heated to 70°C. An acid catalyst solution was fed and mixed continuously into the resin system. The catalyst solution contained 6.7% by weight of ammonium sulphate and 0.82% by weight of polyoxyethene oxide, and was used in the proportions of 6.25 parts of catalyst solution to 78 parts of resin solution. The fibre was collected and cured at 120°C for 3 hours, and was cut up and finally disintegrated in a laboratory disintegrator before being used to make paper. The mean fibre length was 1.7 mm and the mean diameter was 14.5 μ. (The average length used is the average weighted by length; similarly the diameter is the average weighted by diameter.
These averages are used throughout the specification).

The properties of papers containing 25% by weight of urea formaldehyde fibres were determined as follows:—

Bulk cm^3/g	2.20
Tensile strength Nm/g	44.1
Rigidity, "Kodak"* mN.m	0.41
Tear Index mN.m^2/g	11.8
Opacity (75g/m^2) %	75.7
Burst Index KPa.m^2/g	3.57

*"Kodak" is a Registered Trade Mark.

Persons skilled in the art of papermaking will recognise that it is not possible to prepare paper of such a combination of high bulk and tensile and burst properties with all-cellulose furnishes.

EXAMPLE 3

A bleached spruce sulphite pulp was beaten to a freeness of 40 ml. CSF. Papers were made from a mixture of 67% by weight of this pulp and 33% by weight of the urea-formaldehyde fibre described in Example 2. Papers were also made from the sample bleached sulphite pulp alone beaten to a freeness of 600 ml. CSF; the paper made from both furnishes had the same tensile index. The full properties measured on the papers were as follows:—

	33% urea formaldehyde fibre 67% spruce sulphite	**100% spruce sulphite**
Tensile Index N.m/g	48	48
Burst Index KPa.m^2/g	3.3	3.2
Bulk cm^3/g	1.86	1.48
Air resistance, GURLEY Sec.	450	10
ISO Brightness, SCAN, %	80.4	70.6

It is apparent that the composition of the invention has a good balance of bulk and tensile properties, and that the air resistance is better in spite of a significant increase in bulk.

EXAMPLE 4

Mechanical pulp was beaten in a Valley beater to a freeness of 50 ml. CSF. This pulp was used to make paper handsheets containing 10, 20 and 35% by weight of urea formaldehyde fibres (as described in Example 2). The freeness, burst index, bulk and drainage time were measured for each sample (the drainage time was measured as described in the afore-mentioned "A Laboratory Handbook of Pulp and Paper Manufacture" by J Grant p. 85). The mixtures were compared with mechanical pulps of different degrees of beating, chosen because of the similarity of their drainage times to those of the compositions of the invention.

The results of the tests show how, with the compositions as defined, drainage times can be reduced without sacrificing mechanical properties.

EXAMPLE 5

A urea formaldehyde fibre sample was prepared using the method of Example 2 from a resin of formaldehyde: urea molar ratio of 1.6:1. The fibres, of diameter weighted average diameter 17 μ and of length weighted average length of about 6 mm, were made into handsheets with a well beaten groundwood pulp (freeness 14 ml CSF). 32% by weight of the urea formaldehyde fibre was used.

It was observed that in spite of the length of the urea formaldehyde fibre (some fibres up to 10 mm long) the formation of the paper was excellent. The mechanical properties of the paper were measured as follows.

Tear Index	5.5 $mN.m^2/g$
Tensile Index	26 N.m/g
Burst Index	1.35 $KPa.m^2/g$
Bulk	3.0 cm^3/g

EXAMPLE 6

Paper was made on a Fourdinier paper machine using urea formaldehyde fibres as described in the previous paper of Example 5 (though a little shortened by beating to a weighted length of 4 – 5 mm). The paper machine had a wire width of 450 mm and was run at 6 m. per minute.

The web passed over a suction couch roll and via an open drain to the press section, and hence to the drier section. During the production of the paper the web was sampled at the open drain and its solids content measured. A paper containing 20% by weight of the fibre of the invention and equal amounts of beaten birch and pine sulphate pulps (freeness 300 ml. CSF) was made.

The properties of the paper were measured as

Bulk cm^3/g		2.27
Tensile Index N.m/g	Cross Direction	28.5
	Machine Direction	52.8
Tear Index $mN.m^2/g$	Cross Direction	14.5

The paper produced was much bulkier than is normal for a wood-free paper, and maintained good mechanical properties. During the production of the paper the solids content of the paper at the couch roll was determined, and compared with that of an all-cellulose paper (equal amounts of birch and pine sulphate pulp) run under identical conditions.

	With urea formaldehyde Fibre	Cellulose only
Solids content at couch %	16.0	12.1

This indicates the improvements in de-watering that result from using the compositions of the invention.

EXAMPLE 7

A series of experiments were performed to

Drainage Time		Burst Index $KPa.m^2/g$	Bulk cm^3/g
27 secs.	(90% Mechanical pulp (CSF 50 ml) –((10% urea-formaldehyde fibre	1.05	2.27
	100% Mechanical pulp	0.70	2.29
17 secs.	(80% Mechanical pulp (CSF 50 ml) –((20% urea-formaldehyde fibre	0.91	2.38
	100% Mechanical pulp	0.56	2.29
10 secs.	(65% Mechanical pulp (CSF 50 ml) –((35% urea-formaldehyde fibre	0.74	2.61

demonstrate the significance of the length of the urea-formaldehyde fibres on the usefulness of a paper sample, as defined by measuring its tear index. Paper handsheets were prepared using a mechanical pulp beaten to a freeness of 75 ml. CSF. 30% by weight of urea-formaldehyde fibres, as described in Example 2, were incorporated. Four sets of samples were prepared, using urea-formaldehyde fibres of various mean lengths, and the tear index was measured.

Fibre length mm (average weighted by length)	**Tear Index mN.m^2/g**
4.9	3.5
4.0	3.3
2.8	2.8
1.2	2.7

A further sample of urea formaldehyde fibres of mean diameter 8 μ (weighted by diameter) a and mean length 4 mm (weighted by length) was incorporated into paper samples at a 30% by weight level with mechanical pulp (freeness 75 ml. CSF). The tear index of the samples were measured as being 3.3 mN.m^2/g.

EXAMPLE 8

A sample of mechanical pulp, of Freeness 100 ml. CSF, was used to prepare paper handsheets containing urea formaldehyde fibre. The fibre was prepared by centrifugally spinning a resin of formaldehyde: urea ratio 2:1, followed by curing at 120°C. An acid catalyst (ammonium sulphate) was added to the resin before spinning. The mean diameter of the fibre was 17 μ (weighted by diameter) and the mean length (weighted by length) was 4 mm. To the fibre mixtures in water 3% by weight cationic starch was added, based on the fibre weight, this being added at a 10% solution just before papermaking. (When a paper was made using just mechanical pulp and cationic starch, its tensile strength was 33 N.m/g). Materials containing 20% by weight and 50% by weight of urea-formaldehyde fibres were prepared; their properties were determined as follows

	20% urea formaldehyde fibre	**50% urea formaldehyde fibre**
Bulk cm^3/g	2.65	3.0
Tensile Index N.m/g	30	19
Burst Index KPa.m^2/g	1.25	1.15
Tear Index mN.m^2/g	4.0	4.8

The paper samples thus showed excellent combinations of bulk, strength and tear resistance.

EXAMPLE 9

The urea formaldehyde fibre described in Example 8 was used in combination with a birch sulphate pulp beaten to about 300 ml. CSF, and 3% by weight cationic starch added as before. The proportion of urea-formaldehyde fibre used was 20% by weight. The following properties were measured on the paper:—

Bulk cm^3/g	1.94
Burst Index KPa.m^2/g	3.3
Tensile Index N.m/g	49
Tear Index mN.m^2/g	8.4

By comparison, the birch pulp when used alone gave paper of the following properties:—

Bulk cm^3/g	1.56
Burst Index KPa.m^2/g	3.5
Tensile Index N.m/g	52
Tear Index mN.m^2/g	8.0

Which demonstrates the ability of the compositions as described to improve the bulk of a paper without adverse change in mechanical properties.

EXAMPLE 10

A similar composition was used as in Example 9, except that the birch pulp was replaced by pine sulphate pulp. The paper produced had the following properties.

Bulk cm^2/g	1.93
Burst Index KPa.m^2/g	4.3
Tensile Index N.m/g	53
Tear Index mN.m^2/g	10.0

WHAT WE CLAIM IS:—

1. A paper product, including a first fibrous component comprising 5% to 70% by weight of formaldehyde-resin fibres which are insoluble in cold water, which have an average length, weighted by the length of the fibres, of at least 1 mm., which have an average strength ⩾ 50 MNm^{-2} (≡ 33 Nm/g), and which have a mean diameter between 1 μ and 30 μ, and a second fibrous component comprising 30% to 95% by weight of cellulose pulp which comprises a mechanical pulp of freeness no more than 120 ml. CSF (Canadian Standard Freeness) and/or a tensile strength measured on a standard hand sheet of at least 25 Nm/g, and/or a chemical pulp of freeness no more than 400 ml. CSF and/or a tensile strength measured on a standard hand sheet of not less than half the zero span tensile strength.

2. A paper product as claimed in claim 1, wherein the formaldehyde-resin fibres are fibres of urea formaldehyde, melamine formaldehyde, phenol formaldehyde, resorcinol formaldehyde and/or cresol formaldehyde.

3. A paper product as claimed in claim 1 or claim 2, wherein the formaldehyde resin fibres have a mean diameter between 2 μ and 20 μ.

4. A paper product as claimed in claim 3, wherein the formaldehyde resin fibres have a mean diameter between 5 μ and 15 μ.

5. A paper product as claimed in any one of the preceding claims wherein the formaldehyde resin fibres have an average length of at least

2 mm.

6. A paper product as claimed in any one of the preceding claims, wherein the formaldehyde resin fibres have an average strength of at least 100 MNm^{-2} (≡ 67 Nm/g).

7. A paper product as claimed in any one of the preceding claims wherein the formaldehyde resin fibres have been produced by centrifugal spinning.

8. A paper product as claimed in any one of the preceding claims, wherein the mechanical pulp has a freeness not greater than 80 ml. CSF and/or a tensile strength measured on a standard hand sheet of at least 28 Nm/g.

9. A paper product as claimed in any one of the preceding claims, wherein the chemical pulp has a freeness not greater than 300 ml. CSF and/or a tensile strength measured on a standard hand sheet of at least 60% of the zero span tensile strength.

10. A paper product as claimed in any one of the preceding claims, wherein the second fibrous component contains or consists of recycled fibres of the cellulose pulp.

11. A paper product containing formaldehyde resin fibres, substantially as hereinbefore described.

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