

Process of producing a cellulosic fibre web

The invention relates to a process of producing a cellulosic fibre web which may be further processed to air-laid paper, tissue or fluff. The invention also relates to a cellulosic fibre web obtainable from the process and air-laid paper, tissue, or fluff obtainable by further processing of the cellulosic fibre web.

Background of the invention

When manufacturing paper, especially air-laid paper, tissue and fluff, static electricity, measured as static potential, can be a problem. It can cause discharges or sparks, which disturb the production. Furthermore, if the dry fibres have a high static potential the fibres tend to glue themselves to process equipment such as mills, defiberizers and pipes. The fibres are accumulated and discharged as big lumps which create problems when forming the end product. Since the formation of the product usually is made from dry fibres, an even distribution of the fibres is important and lumps of fibres should be avoided. In the production of air-laid paper, uncontrolled static potential can result in extensive dusting which in turn can result in dust explosions. Attempts to reduce the static potential can also lead to deterioration of debonding agents, which may be added to enhance the softness of the product by interfering with natural fibre-to-fibre bonds that occur during sheet formation in the papermaking process.

WO 2007/058609 discloses a process in which the static potential of the fibres/paper product can be controlled and reduced while enhancing the softness of the produced paper product. However, it is desirable to further control the static potential. Also, it is desirable to obtain uniform spreading/dispersion of an antistatic agent. A further object is to increase the retention and effective use of an antistatic agent.

It is a further object of the present invention to provide a process that can smoothly reduce the static potential without risk of overdosing such that the static potential passes zero and becomes considerably negative. According to one embodiment, this can be solved by addition of an antistatic agent without need of further additives. A further object is to provide a process in which a relatively low dosage of an antistatic additive(s) can reduce the static potential to an acceptable level. It is a further object to improve the antistatic effect with a combination of antistatic agents so as to provide a smooth and relatively quick process of reducing and controlling the static potential.

According to one embodiment of the invention, it is a further object of the present invention to provide a process that can control the static potential while maintaining adequate softness and imparting an acceptable defiberization energy to the product.

The invention

The present invention relates to a process of producing a cellulosic fibre web
5 comprising

- a) providing a cellulosic suspension and adding a debonder system to the suspension
- b) dewatering the cellulosic suspension and forming a cellulosic fibre web
- c) applying colloidal silica particles in an amount from about 0.01 to about 5 kg/t
cellulosic fibres to said cellulosic fibre web,

10 wherein no polymer is added to the formed cellulosic fibre web.

It has been found that polymers added to the cellulosic fibre web, in particular cationic polymers, can contribute to an increase in static potential.

The term "cellulosic fibre web" as used herein, includes any sheet or web prepared from cellulosic fibres such as pulp sheets or paper webs.

15 It has been found that addition of colloidal silica particles to a formed cellulosic fibre web prevents interaction thereof with components present in the cellulosic suspension which may disturb the intended purpose, for example to provide controlled antistatic effect while imparting adequate softness to the product.

Colloidal silica particles may be derived from e.g. precipitated silica, micro silica
20 (silica fume), pyrogenic silica (fumed silica) or silica gels with sufficient purity, and mixtures thereof. According to one embodiment, the silica particles are silanised as described in WO2004/035474. The silica sol may also, typically, be produced from waterglass as raw material as disclosed in e.g. US,5,368,833.

Colloidal silica particles and silica sols according to the invention may be
25 modified and can contain other elements such as amines, aluminium and/or boron, which can be present in the particles and/or the continuous phase. Boron-modified silica sols are described in e.g. US 2,630,410. The aluminium modified silica particles suitably have an Al_2O_3 content of from about 0.05 to about 3 wt%, for example from about 0.1 to about 2 wt%. The procedure of preparing an aluminium modified silica sol is further described in
30 e.g. "The Chemistry of Silica", by Iler, K. Ralph, pages 407-409, John Wiley & Sons (1979) and in US 5 368 833.

The colloidal silica particles suitably have an average particle diameter ranging from about 2 to about 150, for example from about 3 to about 50, or from about 5 to about 40 nm. Suitably, the colloidal silica particles have a specific surface area from about 20 to
35 about 1500, for example from about 50 to about 900, or from about 70 to about 600 m^2/g .

According to one embodiment, the anionic colloidal silica particles are hydrophobically modified.

According to one embodiment, colloidal silica particles are added to the formed cellulosic fibre web in an amount from about 0.01 to about 2, or from about 0.1 to about 2, or from about 0.1 to about 1, or from about 0.1 to about 0.75, or from about 0.1 to about 0.5 kg/t dry cellulosic fibres. According to one embodiment, from about 0.1 to about 5 kg, or from about 0.25 to about 1, or from about 0.25 to about 0.75, or from about 0.25 to about 0.5 kg colloidal silica particles/t dry cellulosic fibres are added to the cellulosic fibre web.

According to one embodiment, no further component is added separately or in conjunction with the colloidal silica particles to the formed cellulosic fibre web.

10 According to one embodiment, no or substantially no silicate compound and/or no wet strength agent is added to the cellulosic fibre web.

According to one embodiment, a smectite clay is added to the formed web. According to one embodiment, the smectite clay can be added in an amount from about 0.01 to about 50, for example from about 0.02 to about 10 or from about 0.1 to about 5 or 15 from about 0.2 to about 2 or from about 0.25 to about 0.75 kg/ton dry cellulosic fibres. According to one embodiment, the smectite clay is present in an aqueous dispersion. According to one embodiment, the smectite clay, for example in dispersion form, is sprayed on the web.

According to one embodiment, smectite clays which can be used according to 20 the present invention include for example montmorillonite/bentonite, hectorite, beidelite, nontronite, saponite, and mixtures thereof. According to one embodiment, the smectite clay is laponite and/or bentonite.

According to one embodiment, the smectite clay can be modified e.g. by introducing a cation or a cationic group, such as a quaternary ammonium group or an 25 alkali metal, for example lithium.

According to one embodiment, the smectite clay is a synthetic hectorite clay modified with lithium. This clay is sold under the name Laponite® from Rockwood or Eka Soft F40 from Eka Chemicals AB. Examples of such clays, and the manufacturing of such clays, include those disclosed in WO 2004/000729. The smectite clay used according to 30 the present invention can have a specific surface area from about 50 to about 1500, for example from about 200 to about 1200, or from about 300 to about 1000 m²/g.

Suitable products may be for example Bentonite from Süd-Chemie, BASF and Clayton; Bentolite (Bentonite) from Southern Clay Products; and Hydrotalcite from Akzo Nobel.

According to one embodiment, the smectite clay can be applied by immersion of 35 the cellulosic fibre web into a solution or dispersion of the smectite clay.

The aqueous dispersion of smectite clay can either be produced in advance or dispersed on site. According to one embodiment, the smectite clay is added as a powder.

According to one embodiment, smectite clay is added to the cellulosic suspension, for example in an amount of from about 0.01 to about 10, such as from about 0.05 to about 5, or from about 0.1 to about 2 or from about 0.25 to about 1 kg/ton dry cellulosic fibres.

5 According to one embodiment, the weight ratio of smectite clay added to the cellulosic suspension and smectite clay added to the cellulosic fibre web ranges from about 1:100 to about 100:1 for example from about 5:95 to about 80:20, or from about 10:90 to about 50:50, or from about 15:85 to about 40:60 or from about 20:80 to about 30:70.

10 According to one embodiment, a debonder system such as a debonder composition is added to the suspension. Whereas a debonder composition may comprise one or several components in a mixture which is added jointly or in conjunction to the cellulosic suspension, a debonder system may also involve one or several components which are added separately to the cellulosic suspension.

15 According to one embodiment, a debonder system is added as a pre-mixed emulsion further comprising a polymer as defined herein.

 According to one embodiment, the weight ratio of the debonder system, including the total weight of the components being part of the debonder system, to smectite clay added to the cellulosic fibre web ranges from about 1:50 to about 100:1, for
20 example from about 1:10 to about 50:1 or from about 1:5 to about 20:1, or from about 1:2 to about 10:1, or from about 1:1 to about 5:1.

 According to one embodiment, the weight ratio of the debonder system to silica particles added to the cellulosic fibre web ranges from about 1:50 to about 100:1, for
25 example from about 1:10 to about 50:1 or from about 1:5 to about 20:1, or from about 1:2 to about 10:1, or from about 1:1 to about 5:1.

 According to one embodiment, the debonder system comprises

- (i) an oil, fat or wax,
- (ii) at least one non-ionic surfactant, and
- (iii) at least one anionic surfactant

30 According to one embodiment, the debonder system comprises at least one quaternary ammonium surfactant.

 According to one embodiment, refined and/or hydrogenated grade oils, for example vegetable oils like grape oil, olive oil, coconut oil, rape seed oil, sunflower oil and palm oil, for example coconut oil is comprised in the debonder system.

35 According to one embodiment, mineral oils and/or silicon oil are comprised in the debonder system.

According to one embodiment, the debonder system is free or substantially free from quaternary ammonium surfactants. By "substantially free" is meant that quaternary ammonium surfactants constitute less than 5 wt%, for example less than 1, or less than 0.5 wt% of the total amount of the debonder system.

5 According to one embodiment, the debonder system, i.e. the total amount of component(s) making up the system, is added in an amount from about 0.1 to about 10, for example from about 0.3 to about 7, or from about 0.5 to about 5 kg/ton dry cellulosic fibres.

10 According to one embodiment, to avoid deterioration of the different additives, a preserving agent may be added. Several cosmetic additives can also be included, for example antioxidants, e.g. tocopherol, and aloe vera.

According to one embodiment, the cellulosic fibre web is further processed to produce air-laid paper, tissue or fluff.

15 The present invention also relates to a cellulosic fibre web obtainable by the process as described herein.

The present invention also relates to a cellulosic fibre web comprising silica particles in an amount from about 0.25 to about 1 kg/ton dry cellulosic fibres, or from about 0.25 to about 0.75 kg/ton dry cellulosic fibres wherein the static potential is lower than 5 kV.

20 According to one embodiment, the weight ratio of silica particles added to the web and smectite clay added to the web ranges from about 1:100 to about 100:1 for example from about 1:50 to about 50:1, or from about 1:20 to about 25:1, or from about 1:5 to about 10:1, or from about 1:2 to about 4:1, or from about 1:1 to about 2:1.

25 According to one embodiment, the static potential of the cellulosic fibre web is lower than 10, or lower than 8, or lower than 6, or lower than 5 kV.

According to one embodiment, the defiberization energy of the cellulosic fibre web is lower than 120, such as lower than 110 or lower than 100 kJ/kg.

30 According to one embodiment, the cellulosic fibre web has a dry content of from about 5 to about 99, for example from about 25 to about 95 or from about 50 to about 95 or from about 65 to about 95 or from about 80 to about 95 wt% based on the total weight of the web.

According to one embodiment, the cellulosic fibre web has a dry content from about 20 to about 70, for example from about 30 to about 60 or from about 35 to about 55 wt% based on the total weight of the web.

35 According to one embodiment, at least one polymer such as non-ionic, amphoteric, and/or cationic polymers or mixtures thereof can be added to the cellulosic suspension, in particular polymers which are highly charged. The polymer can be derived

from natural or synthetic sources and can be linear, branched or cross-linked, e.g. in the form of particles. According to one embodiment, the polymer is water-soluble or water-dispersible. According to one embodiment, such at least one polymer can be added in conjunction with a debonder system, for example a debonder composition, in a premix.

- 5 Examples of suitable cationic polymers include cationic polysaccharides, e.g. starches, guar gums, celluloses, chitins, chitosans, glycans, galactans, glucans, xanthan gums, pectins, mannans, dextrans. Suitable starches include potato, corn, wheat, tapioca, rice, waxy maize, barley, etc. Cationic synthetic organic polymers such as cationic chain-growth polymers may also be used, e.g. cationic vinyl addition polymers like acrylate-,
10 acrylamide-, vinylamine-, vinylamide- and allylamine-based polymers, for example homo- and copolymers based on diallyldialkyl ammonium halide, e.g. diallyldimethyl ammonium chloride, as well as (meth)acrylamides and (meth)acrylates. Further polymers include cationic step-growth polymers, e.g. cationic polyamidoamines, polyethylene imines, polyamines, e.g. dimethylamine-epichlorhydrin copolymers, and polyurethanes. Further
15 examples of suitable cationic organic polymers include those disclosed in WO 02/12626.

According to one embodiment, the polymer is selected from the group of polydiallyldimethyl ammonium chloride, polyamines, cationic starch, amphoteric starch, and polyamidoamine-epichlorohydrin (PAAE), polyethylene imines and polyvinylamines.

- The term "step-growth polymer", as used herein, refers to a polymer obtained by
20 step-growth polymerization, also being referred to as step-reaction polymer and step-reaction polymerization, respectively. The term "chain-growth polymer", as used herein, refers to a polymer obtained by chain-growth polymerization, also being referred to as chain reaction polymer and chain reaction polymerization, respectively.

- According to one embodiment, the polymer has a molecular weight of from about
25 10000 to about 10000000, for example from about 15000 to about 5000000, or from about 40000 to about 1000000 g/mol.

According to one embodiment, an anionic polymer such as anionic step-growth polymers, chain-growth polymers, polysaccharides, naturally occurring aromatic polymers and modifications thereof is added to the cellulosic suspension.

- 30 According to one embodiment, the total amount of polymer added ranges from about 0.01 to about 10, such as from about 0.1 to about 5 or from about 0.2 to about 2 kg/ton dry cellulosic fibres.

- According to one embodiment, an aqueous solution containing the polymer is prepared in which the polymer content is from about 0.1 to about 50, such as from about
35 0.5 to about 25 wt% which subsequently is added to the cellulosic suspension.

According to one embodiment, the aqueous polymer solution is heated up to about 20 to about 70, for example up to about 25 to about 55°C. According to one

embodiment, an emulsion of an emollient-surfactant blend and an aqueous solution containing the polymer is prepared with, a static mixer, a high shear device called ultra-turrax or a homogenizer. The emulsion can then be cooled to room temperature. The cooling can be performed for example by means of a heat exchanger.

- 5 According to one embodiment, an anionic surfactant and/or anionic microparticles such as anionic silica particles, for example anionic colloidal silica particles as defined herein, smectite clays, or mixtures thereof are added to the cellulosic suspension.

According to one embodiment, anionic surfactants that can be used according to the invention are for example anionic surfactants with hydrophobic "tails" having from
10 about 6 to about 30 carbon atoms. Examples of anionic surfactants are saponified fatty acids, alkyl(aryl)sulphonates, sulphate esters, phosphate esters, alkyl(aryl)phosphates, alkyl(aryl) phosphonates, fatty acids, naphthalene sulphonate (NAS), formaldehyde polycondensates, polystyrene sulphonates, hydrophobe-modified NAS, for example saponified fatty acids, alkyl(aryl)sulphonates, sulphate esters, phosphate esters,
15 alkyl(aryl)phosphates, alkyl(aryl) phosphonates, and mixtures thereof.

According to one embodiment, the anionic surfactant and/or anionic microparticle is added to the cellulosic suspension in a total amount from about 0.001 to about 1, such as from about 0.005 to about 0.5, or from about 0.01 to about 0.1 kg/ton dry cellulosic fibres.

20 According to one embodiment, non-ionic surfactants that can be used according to the invention include generally ethoxylated or propoxylated fatty acids or fatty alcohols. The ethoxylated fatty acids and fatty alcohols can be ethoxylated with from about 1 to about 30 ethylene oxide (EO), or from about 4 to about 25 EO. The ethoxylated fatty acids and fatty alcohols may have from about 6 to about 30 carbon atoms, or from about
25 6 to about 22 carbon atoms. The propoxylated fatty acids and fatty alcohols may have been propoxylated with from about 1 to about 30 propylene oxide (PO), or from about 1 to about 8 PO. The propoxylated fatty acids and fatty alcohols can have from about 6 to about 30 carbon atoms, such as from about 6 to about 22 carbon atoms. It is also possible to use carbon dioxide instead of propylene oxide.

30 According to one embodiment, a non-ionic surfactant is added in an amount from about 0.1 to about 10, for example from about 0.3 to about 7, or from about 0.5 to about 5 kg/ton dry cellulosic fibres.

According to one embodiment, further conventional components may be added to the cellulosic suspension such as wet strength agents, dry strength agents and wetting
35 agents.

According to one embodiment, the cellulosic fibres of the cellulosic suspension may include fibres derived from wood pulp, which includes chemical pulp such as sulphite

and sulphate pulps, as well as mechanical pulps such as ground wood, thermomechanical pulp and chemical modified thermomechanical pulp. Recycled fibres may also be used. The recycled fibres can contain all the above mentioned pulps in addition to fillers, printing inks etc. Chemical pulps, however, are preferred since they impart a superior feeling of softness to tissue sheets made from it. The utilization of recycled fibres for making tissue or fluff often includes a process step known as deinking to remove as much as possible of the printing ink from the fibre slurry and most of the filler material to get an acceptable brightness of the recycled fibre slurry and paper machine runnability. The deinking process often includes addition of anionic substances such as saponified fatty acids and water glass to the fibre slurry. These substances are sometimes carried over to the paper machine and due to the fact that they are anionic, they can inactivate cationic chemicals added to the stock. These substances are called anionic detrimental substances or "anionic trash".

To evaluate the performance of the papermaking process according to the invention a number of parameters can be measured. To determine the static electricity the static potential is measured. The effect of the debonder system can be determined by measuring knot content, burst strength, defiberization energy and wetting rate. Low burst strength and low defiberization energy shows that the fibre-to-fibre bonds are weak, which enhances the softness.

The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the gist and scope of the present invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the claims. The following examples will further illustrate how the described invention may be performed without limiting the scope of it. If not otherwise stated, all contents and percentages as described herein refer to weight percent.

Example 1

A coconut oil was mixed with a parasubstituted alkyl benzylsulfonic acid (~C12) (anionic surfactant) and an unsaturated fatty alcohol with 16 to 18 carbon atoms being ethoxylated with 5 EO (non-ionic surfactant). The contents of the components were 50 wt% oil, 1 wt% anionic surfactant, and 49 wt% non-ionic surfactants. The oil-surfactant blend was then heated to 50°C. Aqueous solutions with and without a Polyamine Bewoten C410 (polymer) were prepared. The concentration of the polymer in the aqueous solution was 4 wt%. The aqueous solutions were heated separately to 50°C. The oil-surfactant blend was subsequently emulsified into the aqueous solutions by means of an Ultra-Turrax® (high-shear equipment). The compositions were subsequently

cooled to room temperature in a water bath. The weight ratio of the oil-surfactant blend to the aqueous solution was 15:85. The compositions prepared will in the following be referred to as debonder compositions D1 and D2 respectively.

5 The debonder compositions used in the examples:

D1: Eka Soft F61® composed of 3.4 wt% Polyamine Bewoten C410 and the oil-surfactant blend in aqueous solution

D2: Oil-surfactant blend (Eka Soft F60®) in aqueous solution

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The polymer used in the examples:

P1: Polyamine Bewoten C410 (Eka Soft F50®)

P2: Polydadmac (Eka ATC 6340)

The silicious materials used in the examples are:

15 S1: Silica sol (Eka NP 320®)

S2: Eka Soft F40®, a synthetic hectorite, hydrous Sodium Lithium Magnesium Silicate.

S3: Composition containing S1 and S2 in weight ratio 1:1

S4: Composition containing S1 and S2 in weight ratio 2:1

20 S5: Composition containing S1 and Bentonite in weight ratio 1:1

S6: Composition containing S1 and Bentonite in weight ratio 2:1

S7: Composition containing S1 and Bentonite in weight ratio 1:1

25 The silicious materials, S1–S7, either as sole materials or mixtures thereof, were dissolved in water to form an aqueous solution with 1 wt% silicious material. Mixtures S3–S7 are defined in the schedule below:

Comp.	Dry weight ratio Silica:Smectite	NP320 (8 wt%)	Laponite® (6 wt%)	Bentonite (100 wt%)	Water
S3	1:1	75g (1)	100g (2)	-	-
S4	2:1	150g(1)	100g (2)	-	-
S5	1:1	100g(1)	-	8.0g (3)	92(2)
S6	2:1	100g(1)	-	4.0g (3)	46(2)
S7	1:1	100g(1)	-	8.0g (2)	92(3)

The numbers in brackets reflect the addition sequence. The compositions were treated with Ultra-turrax for 10 min at 10.000 rpm.

Dry paper sheets were prepared by mixing 15 grams of chemical pine sulphate pulp with water up to 750 ml. If used, the debonder compositions were added to the pulp suspension followed by 10 minutes of agitation. If used, the silicious materials were added after 8 minutes of agitation. After 10 minutes the formed sheets were prepared in a standard PFI-sheet former (A4 sheets). The sheets were then pressed according to standard method SCAN C26:76. Finally, the sheets were dried on a cylinder to about 90-95% dry content and were then conditioned in a climate room at 23°C and 50% relative humidity. If the additives were sprayed, 10 ml of the diluted product was used, with a concentration appropriate to receive a certain dosage level. The spraying was either conducted on wet paper web after pressing (about 50% dry content) or on dried and conditioned paper web (about 93% dry content). If sprayed on dried and conditioned paper web, the sheets were dried and conditioned once again before measurements were made.

Example 2

In example 2 the defiberization energy and static potential were measured of sheets prepared from different combinations of debonder compositions added to the cellulosic suspension and silicious materials added to the sheets. The amount of debonder composition added to the cellulosic suspension was 2.0 kg/ton based on dry cellulosic fibres. The polymer (Polyamine Bewoten C410) was added in conjunction with the debonder composition or separately in an amount of 0.033 kg/ton based on dry cellulosic fibres. From 0 to 2.0 kg silicious material/ton dry cellulosic fibres was added to the sheets as set out in table 1. The debonder compositions, polymer and silicious materials were added either to the furnish (F) or sprayed on the dried and conditioned paper web (about 93 wt% dry content) (S). Dry paper sheets were prepared according to example 1. The static potential of the sheets was measured with an Electrostatic field measurement device (JCI 148) and a high voltage head JCI (John Chubb Instrumentation 140) connected to a pin-defiberizer. The defiberization is measured in kJ/kg and the static potential is measured in kVolt.

5

Table 1

Test No.	Additives	Total dosage of silicious materials									
		0 kg/ton (kJ/kg)(kV)		0.25 kg/ton (kJ/kg)(kV)		0.5 kg/ton (kJ/kg)(kV)		1.0 kg/ton (kJ/kg)(kV)		2.0 kg/ton (kJ/kg)(kV)	
1	None	165	7.0	-	-	-	-	-	-	-	-
2	Sprayed H ₂ O	159	6.5	-	-	-	-	-	-	-	-
3	P1(F)+D2(S)	80	13.0	-	-	-	-	-	-	-	-
4	D1(S)	90	13.0	-	-	-	-	-	-	-	-
5	D2(F)+P1(F)+ S2(F)	-	-	110	10.0	95	5.0	85	-4.7	-	-
6	D2(F)+P1(F)+ S2(F)+S1(F)	-	-	110	10.0	110	8.0	105	1.7	115	-6.4
7	D2(F)	155	7.0	-	-	-	-	-	-	-	-
8	D2(F)+P1(F)	115	12.5	-	-	-	-	-	-	-	-
9	D2(F)+P1(S)	125	10.0	-	-	-	-	-	-	-	-
10	D2(F)+P1(S)+ S1(S)	-	-	160	7.6	155	6.5	155	3.3	-	-
11	D2(F)+P1(F)+ S2(S)	-	-	105	1.4	105	4.0	100	5.5	-	-
12	D2(F)+P1(F)+ S1(S)	-	-	115	9.0	115	6.8	120	4.0	-	-
13	D2(F)+P1(F)+ S3(S)	-	-	100	5.2	110	5.0	110	1.3	-	-

It is evident from the results of Table 1 that a low static potential can be reached smoothly by addition of colloidal silica particles according to the invention.

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Example 3

In example 3 the static potential of sheets was measured for sole silicious materials. From 0 to 2.0 kg silicious material/ton dry cellulosic fibres were added as set out in table 2. The silicious materials were added either sprayed on the wet paper web (about 50 wt% dry content) (SWP) or the dried and conditioned paper web (about 93 wt%

dry content)(SDP). Dry paper sheets were prepared according to example 1. The static potential was measured in the same way as in example 2.

5

Table 2

Test No.	Additives	Dosage of silicious materials					
		0 kg/ton (kV)	0.125 kg/ton (kV)	0.25 kg/ton (kV)	0.5 kg/ton (kV)	1.0 kg/ton (kV)	2.0 kg/ton (kV)
1	S1 (SWP)	7.6	0.4	-5.4	-3.7	-2.2	-0.8
2	S2 (SWP)	7.6	-1.4	-3.0	-4.0	-4.3	-6.6
3	S1 (SDP)	7.5	0.7	0.7	0.5	-0.3	-0.5
4	S2 (SDP)	7.5	-3.9	-6.9	-8.5	-8.1	-7.3

It is evident from the results of Table 2 that a low static potential can be reached with a low dosage of silica according to tests 1 and 3 of the invention without render the antistatic potential considerably negative.

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Example 4

In example 4 the static potential of sheets was measured for sole silicious materials and combinations thereof. 0 to 0.5 kg silicious material/ton dry cellulosic fibres according to table 3 were added. The silicious materials were sprayed on the wet paper web (about 50 wt% dry content). Dry paper sheets were prepared according to example 1. The static potential was measured in the same way as in example 2.

15

Table 3

Test No.	Additives	Dosage of silicious materials			
		0 kg/ton (kV)	0.125 kg/ton (kV)	0.25 kg/ton (kV)	0.5 kg/ton (kV)
1	None	7.0	-	-	-
2	Sprayed H ₂ O	6.1	-	-	-
3	S1	-	0.4	-5.4	-3.7
4	S2	-	-1.4	-3.0	-4.0
5	S3	-	-	-4.1	-4.6
6	S4	-	-	1.1	-3.0
7	S5	-	-	-0.6	0.7
8	S6	-	-	-0.1	1.4
9	S7	-	-	3.5	1.7

It is evident from the results of Table 3 that a low static potential can be smoothly reached according to the invention.

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Example 5

In example 5 the static potential of the sheets was measured, which sheets were prepared from furnishes containing debonder composition, polymer and Laponite without or with silica sol sprayed on the dried and conditioned paper web (about 93 wt% dry content). The amount of debonder composition added to the cellulosic suspension was 2.0 kg/ton based on dry cellulosic fibres and polymer addition was 0.033 kg/ton based on dry cellulosic fibres. The total amount of silicious material was varied between 0.125 to 2.0 kg silicious material/ton dry cellulosic fibres according to table 4.. Dry paper sheets were prepared according to example 1. The static potential was measured in the same way as in example 2.

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Table 4

Test No.	Additives	Total dosage of silicious materials				
		0.125 kg/ton (kV)	0.25 kg/ton (kV)	0.5 kg/ton (kV)	1.0 kg/ton (kV)	2.0 kg/ton (kV)
1	D2(F)+P1(F)+S2(F)	10.0	10.0	8.0	-1.6	-
2	D2(F)+P1(F)+S2(F)+S1(S)	-	10.0	7.0	-2.8	-7.6

It is evident from the results of Table 4 that a reduced static potential at low dosage levels of colloidal silica while safeguarding a smooth reduction thereof is obtained.

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Example 6

In example 6 the static potential and the defiberization energy were measured of sheets prepared by applying a debonder composition and a polymer to the furnish and silica sol (and in some examples polymer P2) sprayed on the dried and conditioned paper web (about 93 wt% dry content). The amount of debonder composition added to the cellulosic suspension was 2.0 kg/ton based on dry cellulosic fibres and the polymer addition to the suspension was 0.12 kg/ton based on dry cellulosic fibres. The total amount of silicious material was varied between 0.125 to 0.5 kg silicious material/ton dry cellulosic fibres according to table 5. The addition level of P2 (polydadmec, Eka ATC 6340) to the web was varied between 0.125 to 0.5 kg silicious material/ton dry cellulosic fibres according to table 5. Dry paper sheets were prepared according to example 1. The static potential and defiberization energy were measured in the same way as in example 2.

Table 5

Test No.	Additives	Dosage of silicious materials							
		0 kg/ton (kJ/kg)(kV)		0.125 kg/ton (kJ/kg)(kV)		0.25 kg/ton (kJ/kg)(kV)		0.5 kg/ton (kJ/kg)(kV)	
1	D2(F)+P1(F)	120	9.7	-	-	-	-	-	-
2	D2(F)+P1(F)+S1(S) +0.125kg/t P2(S)	-	-	105	9.9	105	12.2	-	-
3	D2(F)+P1(F)+S1(S) +0.25kg/t P2(S)	-	-	-	-	100	9.1	110	8.3
4	D2(F)+P1(F)+S1(S) +0.5 kg/t P2(S)	-	-	-	-	105	8.8	120	8.8
5	D2(F)+P1(F)+S1(S)	-	-	105	9.2	100	8.8	100	7.7

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It is evident from the results of Table 5 that test 5 according to the invention results in lower static potential and/or lower defiberization energy than the tests in which a polymer was applied to the web.

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Claims

1. Process of producing a cellulosic fibre web comprising
 - a) providing a cellulosic suspension and adding a debonder system to the suspension
 - b) dewatering the cellulosic suspension and forming a cellulosic fibre web
 - 5 c) applying colloidal silica particles in an amount from about 0.01 to about 5 kg/t cellulosic fibres to said cellulosic fibre web,wherein no polymer is added to the formed cellulosic fibre web.
2. Process according to claim 1, wherein the colloidal silica particles are added to the web in an amount of from about 0.1 to about 2 kg/ton cellulosic fibres.
- 10 3. Process according to claim 1 or 2, wherein a smectite clay is added to the formed cellulosic fibre web in an amount from about 0.01 to about 50 kg/ton cellulosic fibres.
4. Process according to any one of claims 1 to 3, wherein the colloidal silica particles are sprayed on the web.
- 15 5. Process according to any one of claims 1 to 4, wherein the debonder system comprises
 - (i) an oil, fat or wax,
 - (ii) at least one non-ionic surfactant, and
 - (iii) at least one anionic surfactant
- 20 6. Process according to any one of claims 1 to 5, wherein the debonder system comprises a quaternary ammonium compound.
7. Process according to claim 6, wherein the weight ratio of the debonder system to smectite clay added to the web ranges from about 1:50 to about 100:1.
8. Process according to any one of claims 2 to 7, wherein the smectite clay is
25 laponite and/or bentonite.
9. Process according to any one of claims 1 to 8, wherein the static potential of the cellulosic fibre web is lower than 10 kV.
10. Process according to any one of claims 1 to 9, wherein the defiberization energy of the cellulosic fibre web is lower than 120 kJ/kg.
- 30 11. Process according to any one of claims 1 to 10, wherein the cellulosic fibre web is further processed to produce air-laid paper, tissue or fluff.
12. Process according to any one of claims 1 to 11, wherein the weight ratio of silica to smectite clay added to the cellulosic fibre web ranges from about 1:100 to about 100:1.
- 35 13. Cellulosic fibre web obtainable by the process as claimed in any one of claims 1 to 12.
14. Cellulosic fibre web comprising silica particles in an amount from about 0.25 to about 1 kg/ton dry cellulosic fibres and wherein the static potential is lower than 5 kV.

15. Cellulosic fibre web according to claim 14, wherein the defiberization energy is lower than 120 kJ/kg.