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(54) **FILTER MATERIAL FOR SEGMENTS FOR SMOKING ARTICLES WITH REDUCED CREEP TENDENCY**

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ABSTRACT

Shown is a filter material for manufacturing a segment for a smoking article, wherein the filter material is hydroentangled and contains at least 50% and at most 100% cellulose fibers, each with respect to the mass of the filter material, wherein the filter material has a basis weight of at least 15 g/m² and at most 60 g/m², wherein the thickness of one layer of the filter material, measured in accordance with ISO 534:2011, is at least 25 μm and at most 400 μm, and wherein the filter material has a creep tendency in the thickness direction of at most 10%, wherein the creep tendency is the relative decrease in the thickness of 5 layers of the filter material, measured in accordance with ISO 534:2011, within 20 s after the start of the thickness measurement.

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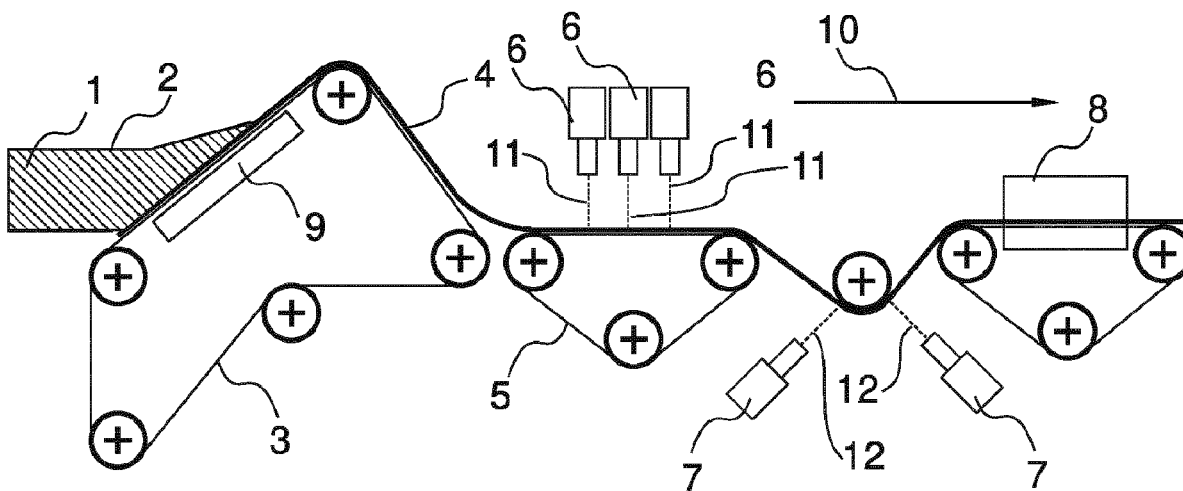
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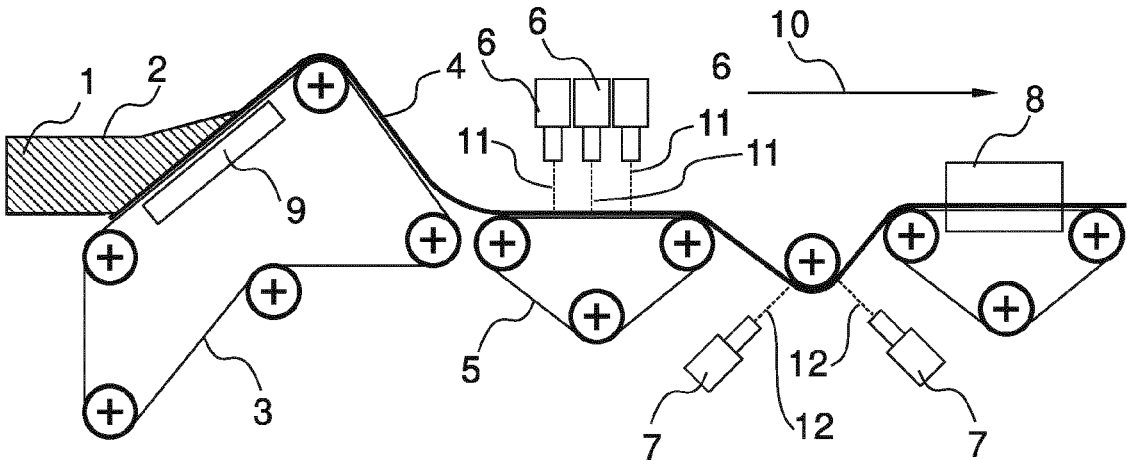


Fig. 1

FILTER MATERIAL FOR SEGMENTS FOR SMOKING ARTICLES WITH REDUCED CREEP TENDENCY

FIELD OF THE INVENTION

[0001] The invention relates to a filter material for a smoking article, a segment for a smoking article manufactured therefrom and a smoking article manufactured therefrom, wherein the filter material has a structure which provides advantageous properties with respect to the creep tendency to a segment manufactured therefrom.

BACKGROUND AND PRIOR ART

[0002] Smoking articles are typically rod-shaped articles which consist of at least two rod-shaped segments disposed next to each other. One segment contains a material which is capable of forming an aerosol upon heating and at least one further segment contains a material that serves to influence the properties of the aerosol.

[0003] The smoking article can be a filter cigarette, in which a first segment contains the aerosol-forming material, in particular tobacco, and a further segment is designed as a filter and acts to filter the aerosol. In this regard, the aerosol is generated by combustion of the aerosol-forming material and the filter primarily serves to filter the aerosol and to provide the filter cigarette with a defined draw resistance.

[0004] The smoking article, however, can also be what is known as a heated tobacco product, wherein the aerosol-forming material is only heated but not burned. This means that the number and amount of substances in the aerosol which are damaging to health are reduced. Such a smoking article also consists of at least two, more often, however, of more, in particular of four segments. One segment contains the aerosol-forming material, which typically comprises tobacco, reconstituted tobacco, tobacco prepared by other processes or nicotine and glycerol or propylene glycol. Further, optional segments in the heated tobacco product sometimes serve to transfer the aerosol, to cool the aerosol or to filter the aerosol.

[0005] The segments are usually wrapped with a wrapper material. Very often, paper is used as wrapper material.

[0006] Unless it is explicitly stated below or is directly clear from the context, the “segment” should be understood to refer to the segment of a smoking article that does not contain the aerosol-forming material, but rather serves, for example, to transfer, cool or filter the aerosol.

[0007] In the prior art, it is known to form such segments from cellulose acetate or polylactides. Because cellulose acetate and polylactides biodegrade only very slowly in the environment, there is an interest in the industry in manufacturing segments of a smoking article from other materials that biodegrade rather better. In the prior art it, is known to manufacture segments for smoking articles, in particular filter segments, from paper. Such segments, however, are in general easily biodegradable, but also suffer from disadvantages. As an example, filter segments from paper in general have a high filtration efficiency and thus lead to a dry aerosol, which deteriorates the taste of the aerosol compared with cigarettes with common filter segments from cellulose acetate. Furthermore, they often have a lower filtration efficiency for phenols than cellulose acetate. It has also been shown to be difficult to manufacture a segment from paper which is acceptable to the consumer with respect to its

combination of draw resistance, filtration efficiency and hardness. In order to reduce the filtration efficiency, less paper is often used, and the segment becomes soft and has too low a draw resistance.

[0008] Thus, there is an interest in the industry for having a filter material available which enables segments for smoking articles to be manufactured which have a good resistance against deformation without creating particular disadvantages with respect to filtration efficiency, draw resistance or biodegradability.

[0009] In the not pre-published international patent application PCT/EP2019/085125 by the same inventor, a hydroentangled filter material is described which can serve as the starting point for the filter material according to the invention.

SUMMARY OF THE INVENTION

[0010] An objective of the invention is to provide a filter material for a smoking article which enables a segment to be produced which, with a similarly good biodegradability, is superior to segments known in the prior art with respect to its resistance to deformation.

[0011] This objective is achieved by means of a filter material according to claim 1, a process for manufacturing the filter material according to claim 27, a segment of a smoking article according to claim 16, a process for manufacturing such a segment according to claim 22 and a smoking article according to claim 23. Advantageous embodiments are provided in the dependent claims.

[0012] The inventors have found that this objective can be achieved by means of a filter material, wherein the filter material is hydroentangled and contains at least 50% and at most 100% cellulose fibers, each with respect to the mass of the filter material, wherein the filter material has a basis weight of at least 15 g/m² and at most 60 g/m², wherein the thickness of one layer of the filter material, measured in accordance with ISO 534:2011, is at least 25 μm and at most 400 μm, and wherein the filter material has a creep tendency in the thickness direction of at most 10%, wherein the creep tendency is the relative decrease in the thickness of 5 layers of the filter material, measured in accordance with ISO 534:2011, within 20 s after the start of the thickness measurement.

[0013] According to the invention, the filter material is manufactured by hydroentangling. This manufacturing process provides the filter material with characteristic properties, which differentiate it from other filter materials and in particular from papers and which cannot be obtained in an identical manner by other manufacturing processes. Other than with paper, for example, in which the strength is primarily caused by hydrogen bonds and the fibers are mainly disposed in the plane of the paper, the strength of the hydroentangled filter material is obtained by entanglement of the fibers. This results in a particularly porous structure, which provides a segment manufactured therefrom with a good combination of draw resistance and filtration efficiency. In particular due to the porous structure, however, such segments are often too soft.

[0014] The inventors have found that having regard to the perception of hardness by the consumer, it is not so important that the segment reacts to a load only with small deformations, but rather that a low but continuing load does not cause large permanent deformations. This is related to the use of smoking articles, in particular filter cigarettes,

where the consumer pinches the cigarette between the fingers in the region of the filter and keeps it in this position while, for example, gesticulating with the same hand and thereby exerting a continuing pressure on the filter region. In this case, the segment of the smoking article should not be substantially permanently deformed. The same holds for smoking articles for tobacco heating systems which, due to the use in a mostly electrically operated heating device, require much more manipulation by the consumer than filter cigarettes.

[0015] The hardness of smoking articles and segments of smoking articles is routinely measured by the deformation due to a brief but high load. According to the findings of the inventors, in the perception of the consumer, the deformation under a continuing but smaller load is more important.

[0016] This problem occurs more often in particular with the use of hydroentangled filter materials, because the advantageous porous structure of the filter material provides little resistance against permanent deformation and in particular, several layers of the filter material, as are typically present in a segment of a smoking article can be compressed easily and permanently deformed due to the crimping or pleating of the filter material. The inventors have found that this problem can be solved by providing the hydroentangled filter material with a structure in which a larger proportion of the fibers of the filter material is oriented in the thickness direction. The fibers oriented in the thickness direction thereby stabilize the porous structure of the filter material and allow a higher resistance against deformation under a continuing small load. The proportion of the fibers oriented in the thickness direction can thereby be influenced by the number and the pressure of the water jets and the shape of the nozzles from which the water jets exit.

[0017] According to the findings of the inventors, the structure of the filter material obtained by this process can be characterized by the creep tendency in the thickness direction, which describes how strongly the filter material is deformed at a low but continuing load. The creep tendency can be determined by the measurement of the thickness in accordance with ISO 534:2011. During the measurement of the thickness in accordance with ISO 534:2011, a sample is placed on a flat support and is put under load by a cylindrical stamp with a defined, but small, force. The distance between the stamp surface and the support is the thickness and is determined in accordance with ISO 534:2011, after the stamp has been placed on the sample.

[0018] The creep tendency can also be determined using a slight variation of this standardized measurement method. In this regard, five layers of the sample material are placed on the support and the thickness measurement in accordance with ISO 534:2011 is started. The value displayed directly after the start of the measurement for the thickness of the five layers (d_0) is recorded and after 20 s, a further value for the thickness of the five layers (d_{20}) is recorded. The creep tendency C is then the relative change in the thickness within these 20 s and can be calculated by the following formula and expressed as a percentage.

$$C = 100 \cdot \frac{d_0 - d_{20}}{d_0}$$

[0019] Experiments on smoking articles have shown that a creep tendency of less than 10% already offers advantages

as perceived by the consumer. Common hydroentangled filter materials, however, typically have a creep tendency of about 15%. According to the invention, the hydroentangled filter material is thus manufactured such that the creep tendency in the thickness direction is at most 10%.

[0020] The filter material according to the invention contains cellulose fibers. According to the findings of the inventors, the cellulose fibers are required in order to provide sufficient strength to the filter material so that it can be processed into a segment. The proportion of cellulose fibers in the filter material is according to the invention at least 50% and at most 100% of the mass of the filter material, but preferably at least 60% and at most 100% and particularly preferably at least 70% and at most 95%, each with respect to the mass of the filter material.

[0021] The cellulose fibers can be pulp fibers or fibers from regenerated cellulose or mixtures thereof.

[0022] The pulp fibers are preferably sourced from coniferous wood, deciduous wood or other plants like hemp, flax, jute, ramie, kapok, coconut, abacá, sisal, bamboo, cotton or esparto grass. In addition, mixtures of pulp fibers of different origin can be used for manufacturing the hydroentangled filter material. Particularly preferably, the pulp fibers are sourced from coniferous wood, because even in small proportions, such fibers provide the filter material with good strength.

[0023] The filter material according to the invention can contain fibers from regenerated cellulose. Preferably, the proportion of fibers from regenerated cellulose is at least 5% and at most 50%, particularly preferably at least 10% and at most 45% and more particularly preferably at least 15% and at most 40%, each with respect to the mass of the filter material.

[0024] The fibers from regenerated cellulose are preferably at least partially, in particular to at least 70%, formed by viscose fibers, Modal fibers, Lyocell® fibers, Tencel® fibers or mixtures thereof. These fibers have good biodegradability and can be used to optimize the strength of the filter material and to adjust the filtration efficiency of the segment manufactured therefrom. Due to their manufacturing process, they are less variable than the pulp fibers obtained from natural sources and contribute to the fact that the properties of a segment manufactured from the filter material vary less than if exclusively pulp fibers are used. Their manufacture, however, requires more effort and they are also usually more expensive than pulp fibers.

[0025] According to the invention, the basis weight of the filter material is at least 15 g/m² and at most 60 g/m², preferably at least 18 g/m² and at most 55 g/m² and particularly preferably at least 20 g/m² and at most 50 g/m². The basis weight influences the tensile strength of the filter material, wherein a higher basis weight generally leads to a higher strength. The basis weight, however, should not be too high, because then the filter material can no longer be processed into segments for smoking articles at high speed. The values refer to a basis weight measured in accordance with ISO 536:2019.

[0026] According to the invention, the filter material has a creep tendency in the thickness direction of at most 10%, preferably of at least 0% and at most 9%, particularly preferably of at least 0% and at most 8% and more particularly preferably of at least 1% and at most 5%. In general, the creep tendency should be as low as possible, but the filter material is deformed during processing into a segment of a

smoking article and it should not offer too great a resistance against this deformation and should also retain a deformed state. The preferred intervals are particularly advantageous in this respect.

[0027] The creep tendency in the thickness direction is determined here as described before in conformity with ISO 534:2011.

[0028] To obtain specific properties, the filter material according to the invention can contain additives such as alkyl ketene dimers (AKD), acid anhydrides, such as alkenyl succinic acid anhydrides (ASA), polyvinyl alcohol, waxes, fatty acids, starch, starch derivatives, carboxy methyl cellulose, alginates, chitosan, wet strength agents or substances for adjusting the pH such as, for example, organic or inorganic acids or bases. Alternatively or additionally, the filter material according to the invention can also contain one or more additives that are selected from the group consisting of citrates such as trisodium citrate or tripotassium citrate, malates, tartrates, acetates such as sodium acetate or potassium acetate, nitrates, succinates, fumarates, gluconates, glycolates, lactates, oxalates, salicylates, α -hydroxy caprylates, phosphates, polyphosphates, chlorides and hydrogen carbonates, and mixtures thereof.

[0029] The skilled person is able to determine the type and amount of such additives from his experience.

[0030] The filter material according to the invention can also comprise yet more substances which better match the filtration efficiency of the filter material to that of cellulose acetate. In a preferred embodiment of the filter material according to the invention, the filter material comprises a substance selected from the group consisting of triacetin, propylene glycol, sorbitol, glycerol, polyethylene glycol, polypropylene glycol, polyvinyl alcohol, triethyl citrate or mixtures thereof.

[0031] In a preferred embodiment of the filter material, at least a portion of the cellulose fibers is loaded with a filler, wherein the filler is particularly preferably formed by mineral particles and in particular by calcium carbonate particles. As the structure of the filter material is very porous, it cannot retain fillers, so that it is advantageous to load the cellulose fibers with the fillers and thereby retain them in the structure of the filter material. Fillers can serve to provide the filler material with special properties.

[0032] The thickness of one layer of the filter material, measured in accordance with ISO 534:2011, is at least 25 μm and at most 400 μm , preferably at least 30 μm and at most 350 μm , particularly preferably at least 35 μm and at most 300 μm . The thickness influences the amount of filter material that can be packed into the segment of the smoking article and thus the draw resistance and filtration efficiency of the segment, but also the processability of the filter material, as it is often crimped or pleated for the manufacture of a segment for a smoking article. For such process steps, too great a thickness is disadvantageous and thicknesses in the preferred and particularly preferred intervals allow for a particularly good processability of the filter material according to the invention into a segment of a smoking article.

[0033] The mechanical properties of the filter material are important for processing the filter material according to the invention into a segment of a smoking article. The tensile strength of the filter material with respect to width, measured in accordance with ISO 1924-2:2008, is preferably at least

0.05 kN/m and at most 5 kN/m, particularly preferably at least 0.07 kN/m and at most 4 kN/m.

[0034] The elongation at break of the filter material is important, because during processing of the filter material according to the invention to form a segment of a smoking article, the filter material is often stretched or loaded in the running direction and a particularly high elongation at break is advantageous thereby. The elongation at break of the filter material, measured in accordance with ISO 1924-2:2008, is thus preferably at least 0.5% and at most 50% and particularly preferably at least 0.8% and at most 40%. The elongation at break is primarily determined by the length of the fibers, wherein longer fibers lead to a higher elongation at break, and it can thus be adjusted to the specific requirements of the filter material within a wide range.

[0035] The tensile strength and the elongation at break can depend on the direction in which samples are taken from the filter material for measurement. The said features of the filter material are each obtained if the tensile strength or the elongation at break in at least one direction lies in the preferred or particularly preferred ranges.

[0036] segments according to the invention for smoking articles can be manufactured from the filter material according to the invention according to processes known in the prior art. These processes comprise, for example, crimping or pleating the filter material, forming a continuous tow from the crimped or pleated filter material, wrapping the continuous tow with a wrapper material and cutting the wrapped tow into individual rods of a defined length. In many cases, the length of such a rod is an integer multiple of the length of the segment that will then be used in the smoking article according to the invention, and therefore, the rods are cut into segments of the desired length before or during manufacture of the smoking article.

[0037] In a further aspect, the invention thus relates to a segment for a smoking article, comprising a filter material and a wrapper material, wherein the filter material contains at least 50% and at most 100% cellulose fibers, each with respect to the mass of the filter material, wherein the filter material has a basis weight of at least 15 g/m^2 and at most 60 g/m^2 , wherein the thickness of one layer of the filter material, measured in accordance with ISO 534:2011, is at least 25 μm and at most 400 μm , and wherein the filter material has a creep tendency in the thickness direction of at most 10%, wherein the creep tendency is the relative decrease in the thickness of 5 layers of the filter material, measured in accordance with ISO 534:2011, within 20 s after the start of the thickness measurement.

[0038] The creep tendency can also be determined in accordance with the aforementioned method on a filter material which is taken from one or more identical segments, insofar as the area and the shape of the outspread filter material is at least sufficient to cover the entire area of the stamp used in the thickness measurement in accordance with ISO 534:2011.

[0039] The segment according to the invention for smoking articles comprises the filter material according to the invention and a wrapper material.

[0040] In a preferred embodiment of the segment according to the invention, the segment is cylindrical with a diameter of at least 3 mm and at most 10 mm, particularly preferably at least 4 mm and at most 9 mm and more particularly preferably at least 5 mm and at most 8 mm.

These diameters are advantageous for the use of the segment according to the invention in smoking articles.

[0041] In a preferred embodiment of the segment according to the invention, the segment has a length of at least 4 mm and at most 40 mm, particularly preferably at least 6 mm and at most 35 mm and more particularly preferably at least 10 mm and at most 28 mm.

[0042] The draw resistance of the segment determined, inter alia, which pressure difference the consumer needs to apply in order to generate a certain volumetric flow through the smoking article and it thus substantially influences the acceptance of the smoking article by the consumer. The draw resistance of the segment can be measured in accordance with ISO 6565:2015 and is given in mm water gauge (mmWG). To a very good approximation, the draw resistance of the segment is proportional to the length of the segment, so that the measurement of the draw resistance can also be carried out on rods that differ from the segment only with respect to their length. The draw resistance of the segment can easily be calculated therefrom.

[0043] The draw resistance of the segment per unit length of the segment is preferably at least 1 mmWG/mm and at most 12 mmWG/mm and particularly preferably at least 2 mmWG/mm and at most 10 mmWG/mm.

[0044] The wrapper material of the segment according to the invention is preferably a paper or a film.

[0045] The wrapper material of the segment according to the invention preferably has a basis weight in accordance with ISO 536:2019 of at least 20 g/m² and at most 150 g/m², particularly preferably at least 30 g/m² and at most 130 g/m². A wrapper material with this preferred or particularly preferred basis weight provides the segment according to the invention wrapped therewith with a particularly advantageous hardness and supports the low creep tendency of the filter material according to the invention in an advantageous manner.

[0046] Smoking articles according to the invention can be manufactured from the segment according to the invention in accordance with processes known in the prior art.

[0047] The smoking article according to the invention comprises a segment that contains an aerosol-forming material and a segment that comprises the filter material according to the invention and a wrapper material.

[0048] Because the cut surface of the segment according to the invention is optically very similar to that of a segment produced from cellulose acetate, in a preferred embodiment, the segment located next to the mouth end of the smoking article is a segment according to the invention.

[0049] In a preferred embodiment, the smoking article is a filter cigarette and the aerosol-forming material comprises tobacco.

[0050] In a preferred embodiment, the smoking article is a smoking article, during the intended use of which the aerosol-forming material is only heated but not burned and the aerosol-forming material comprises a material selected from the group consisting of tobacco, reconstituted tobacco, nicotine, glycerol, propylene glycol or mixtures thereof. Here, the aerosol-forming material can also be present in liquid form and be located in a suitable container in the smoking article.

[0051] The filter material according to the invention can be manufactured according to the following process according to the invention, which comprises the steps A to C.

[0052] A—providing a fiber web comprising cellulose fibers,

[0053] B—hydroentangling the fiber web by water jets directed onto the fiber web, to produce a hydroentangled fiber web,

[0054] C—drying the hydroentangled fiber web,

[0055] wherein in step A, the amount or the proportion of cellulose fibers is selected such that after drying in step C, the filter material contains at least 50% and at most 100% cellulose fibers with respect to the mass of the filter material, and

[0056] wherein in step B, the number of water jets, the pressure of the water jets or the shape of the openings from which the water jets exit are selected such that after the drying in step C, the filter material has a creep tendency in the thickness direction of at most 10%, wherein the creep tendency is the relative decrease in the thickness of 5 layers of the filter material, measured in accordance with ISO 534:2011, within 20 s after the start of the thickness measurement, and after drying in step C, the filter material has a basis weight of at least 15 g/m² and at most 60 g/m² and the thickness of one layer of the filter material, measured in accordance with ISO 534:2011, is at least 25 μm and at most 400 μm.

[0057] The water jets directed onto the fiber web in step B cause an entanglement of the cellulose fibers, wherein a proportion of the fibers are oriented in the thickness direction and thereby contribute to the reduction in the creep tendency. The “pressure of the water jet” will be understood by the skilled person to be that pressure which is used to generate the water jet, for example in a pressure chamber. Generally, the proportion of fibers oriented in the thickness direction can be increased and thus the creep tendency of the filter material can be reduced when a large number of water jets is selected and a comparatively high pressure is used at them the machine direction first one to three rows of water jets in the machine direction. In a particularly preferred embodiment, at least a portion of the nozzles from which the water jets exit in step B is shaped as round holes in a nozzle strip, wherein the diameter of the holes on both sides of the nozzle strip is different. In this embodiment, the diameter of the holes facing the filter material is greater than the diameter of the holes facing away from the filter material and is at most twice as large as the diameter of the holes facing away from the filter material. According to the findings of the inventors, this shape for the nozzles is particularly suitable, because a sharp water jet is generated thereby which, in connection with the higher pressure, makes a greater contribution to orienting the fibers in the thickness direction.

[0058] The filter material manufactured according to this process should be suitable for use in segments for smoking articles. This means that in particular, it has all the features, individually or in combination, which were described above in connection with the filter material and are defined in the claims directed to the filter material.

[0059] In a preferred embodiment of the process according to the invention, providing a fiber web in step A comprises spinning a plurality of cellulose fibers, wherein the cellulose fibers are formed by filaments of regenerated cellulose and wherein at least 90% of the mass of the filter material after drying in step C is formed by the filaments from regenerated

cellulose. In a particularly preferred embodiment of this process, the filaments from regenerated cellulose are Lyocell® filaments.

[0060] In a further preferred embodiment of the process according to the invention, providing a fiber web in step A comprises the following steps A1 to A4.

[0061] A1—providing an aqueous suspension comprising cellulose fibers,

[0062] A2—applying the suspension of step A1 to a running wire,

[0063] A3—de-watering the suspension through the running wire in order to form a fiber web,

[0064] A4—transferring the fiber web of step A3 onto a support wire.

[0065] In a preferred embodiment of the process according to the invention, the aqueous suspension in step A1 has a solids content of at most 3.0%, particularly preferably at most 1.0%, more particularly preferably at most 0.2% and in particular at most 0.05%. The particularly low solids content of the suspension enables a fiber web with low density to be formed in step A3, which is advantageous for the filtration efficiency of a segment manufactured therefrom.

[0066] In a preferred embodiment of the process according to the invention, the running wire in steps A2 and A3 is inclined in the running direction of the fiber web upwards relative to the horizontal by an angle of at least 3° and at most 40°, particularly preferably by an angle of at least 5° and at most 30° and more particularly preferably by an angle of at least 15° and at most 25°.

[0067] In a preferred embodiment, the process comprises a step in which a pressure difference between the two sides of the running wire is applied in order to support the de-watering of the suspension in step A3, wherein particularly preferably, the pressure difference is generated by vacuum boxes or suitably shaped foils.

[0068] In a preferred embodiment of the process according to the invention, a plurality of water jets is used in order to carry out the hydroentangling in step B, wherein the water jets are arranged in at least one row transverse to the running direction of the fiber web.

[0069] In a preferred embodiment of the process according to the invention, the hydroentangling in step B is carried out by at least four rows of water jets directed onto the fiber web, wherein particularly preferably, at least two rows of water jets act on each of the two sides of the fiber web.

[0070] In a preferred embodiment of the process according to the invention, the process comprises a further step in which one or more additives are applied to the fiber web. The additives are preferably selected from the group consisting of alkyl ketene dimers (AKD), acid anhydrides such as alkenyl succinic acid anhydrides (ASA), polyvinyl alcohol, waxes, fatty acids, starch, starch derivative, carboxy methyl cellulose, alginates, chitosan, wet strength agents or substances for adjusting the pH such as, for example, organic or inorganic acids or bases, and mixtures thereof. Alternatively or additionally, one or more additives can be applied which are selected from the group consisting of citrates such as trisodium citrate or tripotassium citrate, malates, tartrates, acetates such as sodium acetate or potassium acetate, nitrates, succinates, fumarates, gluconates, glycolates, lactates, oxalates, salicylates, α -hydroxy caprylates, phosphates, polyphosphates, chlorides and hydrogen carbonates and mixtures thereof.

[0071] In a preferred embodiment of the process according to the invention, the application of the additive or the additives is carried out between steps B and C of the process according to the invention. In a further preferred embodiment of the process according to the invention, the application of the additive or the additives is carried out after step C, followed by a further step for drying the fiber web.

[0072] In a preferred embodiment of the process according to the invention, the drying in step C is at least partially carried out by contact with hot air, by infra-red radiation or by microwave radiation. Drying by direct contact with a heated surface is also possible, but less preferred, because the thickness of the hydroentangled filter material could be reduced thereby.

BRIEF DESCRIPTION OF THE FIGURE

[0073] FIG. 1 shows a device with which the process according to the invention for manufacturing the filter material according to the invention can be carried out.

DESCRIPTION OF THE PREFERRED EXEMPLARY EMBODIMENTS AND OF A COMPARATIVE EXAMPLE

[0074] Some preferred embodiments of the filter material, of the process for manufacturing the filter material, of the segment for smoking articles and of the smoking article are described below. Furthermore, a comparative example which is not in accordance with the invention is described.

[0075] The device shown in FIG. 1 was used to manufacture the filter material.

[0076] A suspension 1 of pulp fibers and fibers of regenerated cellulose was provided in a storage tank 2, step A1, and was pumped from there to a running wire 3, inclined upwards relative to the horizontal, step A2, and was de-watered through vacuum boxes 9, step A3, so that a fiber web 4 was formed on the wire, the general direction of movement of which is indicated by the arrow 10. The fiber web 4 was taken off the wire 3 and transferred onto a support wire 5 which was also running, step A4. There, water jets 11 arranged in several rows transverse to the running direction of the fiber web 4 from devices 6 were directed onto the fiber web 4 to entangle the fibers and to consolidate the fiber web 4 to form a nonwoven, step B. In continuation of step B, water jets 12 were also directed onto the other side of the fiber web 4 by additional devices 7. Then the still-moist nonwoven ran through a drying unit 8 and was dried, step C, in order to obtain the filter material.

Exemplary Embodiments

[0077] To manufacture the hydroentangled filter material, a mixture of pulp fibers produced from coniferous woods and Lyocell® fibers was used, wherein the amount of fibers was selected such that the finished filter material consisted of 80% pulp fibers and 20% Lyocell® fibers. The finished filter material had a basis weight, in accordance with ISO 536:2019, of 25 g/m².

[0078] In step B of the manufacturing process, firstly, water jets in three rows, 11 in FIG. 1, were directed onto the first side of the fiber web 4 and then water jets in two rows, 12 in FIG. 1, were directed onto the second side of the fiber web. In this regard, the pressure of the water jets in the first three rows was varied between about 3 MPa and about 8 MPa in three steps (low, medium, high), in order to obtain different filter materials according to the invention A, B and C.

[0079] The creep tendency in the thickness direction was determined in conformity with ISO 534:2011 for these filter materials. In this regard, 5 layers of the filter material were stacked one upon the other and the measurement of the thickness in accordance with ISO 534:23011 was started. The first measured value for the thickness of the five layers (d_0) was recorded and a further value for the thickness of the five layers (d_{20}) was recorded 20 s after the first value. The creep tendency C in the thickness direction was determined therefrom according to the following formula.

$$C = 100 \cdot \frac{d_0 - d_{20}}{d_0}$$

[0080] The measurement was repeated three times for each of the three filter materials. In addition, the thickness d of a single layer was determined in accordance with ISO 534:2011 from an average of 10 measurements.

[0081] The results are shown in Table 1, wherein d is the thickness of a single layer, d_0 is the thickness of the five layers at the start of the measurement, d_{20} is the thickness of the five layers 20 s after the start of the measurement and C is the creep tendency.

TABLE 1

Filter Material	Pressure	d [μm]	d_0 [μm]	d_{20} [μm]	C [%]
A	High	273	1345	1317	2.08
A	High		1387	1347	2.88
A	High		1365	1321	3.22
B	Medium	240	1185	1138	3.97
B	Medium		1230	1179	4.15
B	Medium		1255	1197	4.62
C	Low	204	1067	1016	4.78
C	Low		1007	953	5.36
C	Low		1000	942	5.80

[0082] The values from Table 1 show that the determination of the creep tendency exhibits good repeatability, and thus is a reliable measurement method. It is also noticeable that the creep tendency of the filter material increases with lower pressure of the water jets.

Comparative Example Z

[0083] To manufacture a filter material not according to the invention, the same mixture of fibers was used as with the exemplary embodiments A to C. In step B, however, only one row of water jets and a lower pressure than with comparative example C were chosen, while the basis weight remained unchanged at 25 g/m².

[0084] For the filter material Z not according to the invention, the same measurements were carried out as for the filter materials according to the invention A to C and the results are shown in Table 2, wherein the symbols are identical to Table 1.

TABLE 2

Filter Material	d [μm]	d_0 [μm]	d_{20} [μm]	C [%]
Z	186	947	838	11.51
Z		903	787	12.85
Z		934	796	14.78

[0085] It can be seen that the chosen lower number of water jets and the lower but quite common pressure of the water jets for the filter material not according to the invention lead to a substantially higher creep tendency in the thickness direction than for the exemplary embodiments according to the invention A to C.

[0086] Furthermore, it can be seen that the thickness of the single layer also decreases with the reduction in pressure of the water jets in the order of the exemplary embodiments of A, B, C, and Z. This is an indication that in the exemplary embodiments according to the invention, A to C, a higher proportion of fibers is arranged in the thickness direction than in comparative example Z.

Manufacture of Segments and Smoking Articles

[0087] Filter rods wrapped with paper and with a length of 100 mm and a diameter of 7.85 mm were manufactured from each filter material of the embodiments A to C and from the comparative example Z. The width of the web of filter material and the machine settings during manufacture of the filters were selected here such that a draw resistance of 420±10 mmWG was obtained. Segments with a length of 20 mm were cut from the filter rods and American Blend cigarettes were produced therefrom with a length of 83 mm without filter ventilation. The mean weight of the cigarettes was 925.8 mg.

[0088] The cigarettes were smoked according to a process specified in ISO 3308:2012 and the amount of nicotine-free dry particulate matter per cigarette was determined. The filter segments of the cigarettes were removed and the amount of nicotine-free dry particulate matter in each filter segment was also determined and the filtration efficiency was calculated as a percentage therefrom, wherein the filtration efficiency indicates which proportion of the nicotine-free dry particulate matter flowing into the filter segment is retained. In addition to the properties of the filter material, the filtration efficiency therefore also depends on the length and the diameter of the filter segment.

[0089] The hardness of the filter rods was measured with a DD60A instrument from Borgwaldt KC. In this regard, the filter rods are loaded with a defined force by a test body and the deformation is measured and expressed as a percentage with respect to the undeformed state.

[0090] The draw resistance (PD) of the filter rod, the filtration efficiency (FE) for nicotine-free dry particulate matter and the hardness (HD) of the filter segments are shown in Table 3 for the exemplary embodiments A to C according to the invention and the comparative example Z.

TABLE 3

Example	PD mmWG	FE %	HD %
A	420	56.3	80
B	418	56.9	80
C	425	53.5	78
Z	420	72.0	76

[0091] It can be seen from Table 3 that both the segments according to the invention from the filter materials A to C as well as from the filter material Z not according to the invention have similar draw resistance, filtration efficiency

and hardness, so that the segments according to the invention can readily meet the usual requirements for segments for smoking articles.

[0092] In particular, for the hardness of the segments, which is usually measured by a short but high load, no substantial differences can be seen. During experimental smoking of the smoking articles manufactured from the segments, however, a perceptible difference was found as regards how far the filter segments deformed when the consumer held them between the fingers for a longer time. In this subjective evaluation, the filter materials according to the invention and the segments manufactured therefrom exhibit significant advantages.

[0093] Thus, it can be seen that segments can be manufactured from the filter material according to the invention for which the properties with respect to draw resistance, filtration efficiency and hardness correspond to common segments but which have further advantages with respect to the creep tendency and thus come closer overall to segments from cellulose acetate than filter materials from paper, for example. With respect to the biodegradability, the filter materials according to the invention and the segments manufactured therefrom are even more superior to common segments from cellulose acetate.

1. Filter material for manufacturing a segment for a smoking article, wherein the filter material is hydroentangled and contains at least 50% and at most 100% cellulose fibers, each with respect to the mass of the filter material,

wherein the filter material has a basis weight of at least 15 g/m² and at most 60 g/m²,

wherein the thickness of one layer of the filter material, measured in accordance with ISO 534:2011, is at least 25 μm and at most 400 μm, and wherein the filter material has a creep tendency in the thickness direction of at most 10%, wherein the creep tendency is the relative decrease in the thickness of 5 layers of the filter material, measured in accordance with ISO 534:2011, within 20 s after the start of the thickness measurement.

2. Filter material according to claim 1, in which the proportion of cellulose fibers in the filter material is at least 70% and at most 95%, each with respect to the mass of the filter material.

3. Filter material according to claim 1, in which the cellulose fibers are formed by pulp fibers, by fibers from regenerated cellulose or mixtures thereof.

4. (canceled)

5. Filter material according to claim 3, in which the proportion of fibers from regenerated cellulose is at least 5% and at most 50% with respect to the mass of the filter material.

6. (canceled)

7. Filter material according to claim 1, with a basis weight of at least 20 g/m² and at most 50 g/m².

8. Filter material according to claim 1, wherein the filter material has a creep tendency in the thickness direction of at least 1% and at most 5%.

9. (canceled)

10. (canceled)

11. Filter material according to claim 1, which contains at least one substance selected from the group consisting of triacetin, propylene glycol, sorbitol, glycerol, polyethylene

glycol, polypropylene glycol, polyvinyl alcohol and triethyl citrate, or a mixture of two or more of the at least one substances.

12. Filter material according to claim 1, in which at least a portion of the cellulose fibers is loaded with a filler, wherein the filler is formed by calcium carbonate particles.

13. Filter material according to claim 1, in which the thickness of one layer of the filter material, measured in accordance with ISO 534:2011, is at least 30 μm and at most 350 μm.

14. (canceled)

15. (canceled)

16. Segment for a smoking article, comprising a filter material and a wrapper material, wherein the filter material contains at least 50% and at most 100% cellulose fibers, each with respect to the mass of the filter material,

wherein the filter material has a basis weight of at least 15 g/m² and at most 60 g/m²,

wherein the thickness of one layer of the filter material, measured in accordance with ISO 534:2011, is at least 25 μm and at most 400 μm, and wherein the filter material has a creep tendency in the thickness direction of at most 10%, wherein the creep tendency is the relative reduction of thickness of 5 layers of the filter material, measured in accordance with ISO 534:2011, within 20 s after the start of the thickness measurement.

17. Segment according to claim 16, in which the filter material has one or more of the additional features that are defined in claim 2.

18. Segment according to claim 16, wherein the segment is cylindrical with a diameter of at least 4 mm and at most 9 mm, and/or wherein the segment has a length of at least 6 mm and at most 35 mm.

19. Segment according to claim 16, wherein the draw resistance of the segment in accordance with ISO 6565:2015 per unit length of the segment is at least 1 mmWG/mm and at most 12 mmWG/mm.

20. (canceled)

21. Segment according to claim 16, in which the wrapper material has a basis weight in accordance with ISO 536:2019 of at least 30 g/m² and at most 130 g/m².

22. Process for manufacturing a segment according to claim 16, in which the filter material according to claim 1 is crimped or pleated, a continuous tow of crimped or pleated filter material is formed and the tow of crimped or pleated filter material is wrapped with a wrapper material and the wrapped tow is cut into individual rods of a defined length.

23. Smoking article comprising a segment which contains an aerosol-forming material, and a segment according to claim 16.

24. Smoking article according to claim 23, wherein the smoking article is a filter cigarette and the aerosol-forming material is or contains tobacco.

25. Smoking article according to claim 23, wherein the smoking article is a smoking article in which, during its intended use, the aerosol-forming material is only heated but not burned, wherein the aerosol-forming material comprises a material selected from the group consisting of tobacco, reconstituted tobacco, nicotine, glycerol, propylene glycol or mixtures thereof.

26. Smoking article according to claim 25, wherein the aerosol-forming material is present in liquid form and located in a corresponding container in the smoking article.

27. Process for manufacturing a filter material, wherein the process comprises the following steps:

- A—providing a fiber web comprising cellulose fibers,
- B—hydroentangling the fiber web by water jets directed onto the fiber web, in order to manufacture a hydroentangled fiber web,
- C—drying the hydroentangled fiber web,

wherein in step A, the amount or the proportion of cellulose fibers is selected such that after drying in step C, the filter material contains at least 50% and at most 100% cellulose fibers with respect to the mass of the filter material, and

wherein in step B, the number of water jets, the pressure of the water jets or the shape of the openings from which the water jets exit are chosen such that after drying in step C, the filter material has a creep tendency in the thickness direction of at most 10%,

wherein the creep tendency is the relative decrease in the thickness of 5 layers of the filter material, measured in accordance with ISO 534:2011, within 20 s after the start of the thickness measurement, and

after drying in step C, the filter material has a basis weight of at least 15 g/m² and at most 60 g/m² and the thickness of one layer of the filter material, measured in accordance with ISO 534:2011, is at least 25 μm and at most 400 μm.

28. Process according to claim 27, in which at least a portion of the nozzles, from which the water jets exit in step B is shaped as round holes in a nozzle strip, wherein the diameter of the holes in the nozzle strip facing the filter material is greater than the diameter of the holes facing away from the filter material and at most twice the diameter of the holes facing away from the filter material.

29. Process according to of claim 27, wherein the filter material manufactured according to this process is a filter material according to claim 1.

30. Process according to claim 27, in which the provision of a fiber web in step A comprises spinning a plurality of cellulose fibers, wherein the cellulose fibers are formed by filaments of regenerated cellulose and wherein at least 90%

of the mass of the filter material after drying in step C is formed by the filaments of regenerated cellulose.

31. Process according to claim 27, in which the provision of a fiber web in step A comprises the following steps A1 to A4:

- A1—producing an aqueous suspension comprising cellulose fibers,
- A2—applying the suspension from step A1 to a running wire,
- A3—de-watering the suspension through the running wire to form a fiber web,
- A4—transferring the fiber web from step A3 onto a support wire.

32. Process according to claim 31, in which the aqueous suspension in step A1 has a solids content of at most 0.2%.

33. (canceled)

34. (canceled)

35. (canceled)

36. Process according to claim 35, in which the hydroentangling in step B is carried out by at least four rows of water jets directed onto the fiber web, wherein at least two rows of water jets act on each of the two sides of the fiber web.

37. Process according to of claim 27, which comprises a further step in which one or more additives are applied to the fiber web, wherein the one or more additives is or are selected from the group consisting of alkyl ketene dimers (AKD), acid anhydrides, alkenyl succinic acid anhydrides (ASA), polyvinyl alcohol, waxes, fatty acids, starch, starch derivatives, carboxy methyl cellulose, alginates, chitosan, wet strength agents and substances for adjusting the pH, organic or inorganic acids or bases, and mixtures thereof.

38. (canceled)

39. Process according to claim 27, in which the one or more additives are applied between the steps B and C, or after step C, followed by a further step of drying the fiber web.

40. (canceled)

41. A smoking article of claim 23, wherein said segment according to claim 16 is the segment of the smoking article located closest to the mouth end.

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