MERCERIZATION PROCESS OF PULP TO PRODUCE HIGH POROUS MATERIAL

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This invention relates to mercerized cellulose fibers which form a fibrous web that exhibit an Air Porosity equal to or greater than about 100 cfm/sq ft as determined by the procedure of TAPPI T251 cm-85 on 60 gsm handsheets at a pressure of 125 Pa, and preferably having a kink index equal to or greater than about 2.5 and a curl index equal to or greater than about 0.28 as measured by Fibers Quality Analyzer (FQA) manufactured by Optest, Canada.
Figure 1

unmercerized fiber

Figure 2

mercerized fiber
MERCERIZATION PROCESS OF PULP TO PRODUCE HIGH POROUS MATERIAL

FIELD OF THE INVENTION

[0001] This invention relates to a process for manufacture of mercerized cellulose fibers and fibrous product prepared therefrom. The invention also relates to the cellulose fibers, cellulosic sheet materials containing the fibers, and products manufactured there from such as automotive oil, air filters, and tobacco products.

BACKGROUND OF THE INVENTION

[0002] Mercerized fibers and products made there from are known and described and disclosed in U.S. Pat. Nos. 5,766,159 and 6,063,982 incorporated herein by reference as if fully set forth.

SUMMARY OF THE INVENTION

[0003] One aspect of this invention relates to mercerized cellulose fibers which form a fibrous web that exhibit an Air Porosity equal to or greater than about 100 cfm/sq ft as determined by the procedure of TAPPI T251 cm-85 on 60 gsm handsheets at a pressure of 125 Pa, and preferably having a kink index equal to or greater than about 2.5 and a curl index equal to or greater than about 0.28 as measured by Fibers Quality Analyzer (FQA) manufactured by Optest, Canada. Another aspect of this invention relates to a porous fibrous web or a paper or paperboard substrate comprising the mercerized fibers of this invention. The porosity characteristics of the web make it useful in those applications where web porosity is desirable.

[0004] Still another aspect of this invention relates to a porous or non-porous paper or paperboard substrate comprising the mercerized fibers of this invention. Yet another embodiment of this invention relates to an article of manufacture having a body all or a portion of which is formed from a fibrous web comprising the mercerized fibers of this invention. There are other articles, but are not limited to absorbent article for absorbing fluids such as the personal hygiene articles, sanitary napkins, tampons, diapers, incontinence pads, surgical sponges, compresses, bandage, and wipes as disclosed and described in U.S. Pat. Nos. 5,766,159 and 6,063,982 and filter articles as disclosed and described in U.S. Pat. Nos. 6,797,044 and 6,767,391 and oil filters as disclosed and described in U.S. Pat. Nos. 6,706,181 and 6,379,537. Still another aspect of this invention relates to a process for forming the mercerized fibers of this invention which comprises treating cellulosic fibers with a mercerization agent at a concentration and temperature and for a time sufficient to form the mercerized cellulose fibers of this invention. To achieve the expected results, it is essential for the operation to be conducted with a mercerization liquor rich in dissolved carbohydrates, such as the recirculated mercerization solution as-is in its full alkaline condition.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] The above and other aspects and advantages of the invention will now be further described in conjunction with the accompanying drawings in which:

[0006] FIG. 1 illustrates an unmercerized fiber;

[0007] FIG. 2 illustrates the mercerized form of the fiber of FIG. 1;

[0008] FIG. 3 illustrates a contour length of fiber; and

[0009] FIG. 4 is a graph illustrating an Air Permeability v.s. different specimen of mercerized fiber testing under TAPPI T251 cm-85 on 60 gsm handsheets at a pressure of 125 Pa.

DETAILED DESCRIPTION OF THE INVENTION

[0010] The mercerized cellulose fibers that formed into a fibrous web exhibit an Air Porosity equal to or greater than about 100 cfm/sq ft as determined by the procedure of TAPPI T251 cm-85 on 60 gsm handsheets at a testing pressure of 125 Pa. Preferably the Air Porosity is equal to or greater than about 110 cfm/sq ft. In the more preferred embodiments of this invention, the fibrous web has Air Porosity equal to or greater than about 115 cfm/sq ft and most preferably equal to or greater than about 120 cfm/sq ft.

[0011] Preferably the mercerized fibers of this invention exhibits a curl index equal to or greater than about 0.26 as determined by the Fiber Quality Analyzer manufactured and sold by Optest-Canada. Curl index and methods of measuring same are well known in the art. In the preferred embodiments of this invention, the fibers have a curl index of from about 0.275 to about 0.370 and most preferably from about 0.285 to about 0.360.

[0012] Preferably the mercerized fibers of this invention exhibits a kink index equal to or greater than about 2.5 as determined by Fiber Quality Analyzer manufactured and sold by Optest-Canada. Kink index and methods of measuring same are well known in the art. In the preferred embodiments of this invention, the fibers have a kink index of from about 2.50 to about 2.80. The kink index of the fibers is more preferably from about 2.55 to about 2.75 and most preferably from about 2.60 to about 2.70.

[0013] The mercerized fibers of this invention can be formed of pulp fibers derived from hardwood trees, softwood trees, or a combination of hardwood and softwood trees of the type prepared for use in a papermaking furnish by any known suitable digestion, refining, and bleaching operations as for example known mechanical, thermo mechanical, chemical and semi chemical, etc., pulping and other well known pulping processes. In certain embodiments, at least a portion of the pulp fibers may be provided from non-woody herbaceous plants and/or agricultural residues including, but not limited to, kenaf, sugarcane bagasse, hemp, jute, flax, sisal, or abaca although legal restrictions and other considerations may make the utilization of hemp and other fibers sources impractical or impossible. Fiber resources may also include recycled or post-consumer fibers or any cellulose-based textile residues. Either bleached or unbleached pulp fibers may be utilized in the process of this invention. In the preferred embodiments of the invention mixtures of pulp fibers formed from hardwoods and softwoods are used. In the more preferred embodiments of the invention the major portion of the fibers (greater than 50% by wt, preferably greater than 60% by wt and more preferably greater than about 80% by wt) are derived from bleached softwoods and in the more preferred embodiments of the invention all or substantially all of the fibers are derived from softwoods.
The mercerized pulp fibers of this invention are prepared by treating a suitable cellulosic fiber with a suitable mercerization agent at a concentration and for a time and at a temperature sufficient to form a mercerized pulp fiber having the desired characteristics. For example, a cellulosic wood fiber selected from the group consisting of bleached and unbleached softwood, hardwood, and bagasse, preferably bleached softwood fiber can be combined with an amount of water to form the slurry. The amount of water combined with the wood fibers is that amount which is sufficient to form the slurry preferably having a consistency in the range of from about 0.1 to about 88 wt. %, and preferably in the range of from about 8 to about 40 wt. %. Consistency is defined as the oven dry weight of the wood fibers in the slurry, divided by the total weight of the slurry. To achieve high porosities it is essential to conduct the mercerization step using mercerization liquors highly enriched in dissolved hemicelluloses (continuously reused and/or further artificially enriched with added soluble carbohydrates), so that only the high molecular weight carbohydrates (mostly hemicelluloses) can reprecipitate out of solution onto the surface of the fibers during mercerization.

After forming the slurry, the slurry is treated with a mercerized solution formed by combining a suitable mercerization agent or a combination of two or more of such agents with a polar solvent such as water. Suitable mercerization agents include inorganic bases such as alkali metal and alkaline earth metal hydroxides as for example potassium hydroxide, lithium hydroxide and sodium hydroxide, sodium carbonate and ammonium hydroxide and various amines and amides used in mercerization of pulp fibers, white liquor (e.g., caustic solution containing Na₂S and Na₂CO₃), or a combination of two or more of the foregoing compounds or mixtures with an amount of polar solvent such as water. Preferred mercerization agents are alkali metal hydroxides and more preferred mercerization agents are potassium hydroxide and sodium hydroxide.

The treatment effectiveness is dependent on both the concentration of the mercerization agent and the temperature, but also in the utilization of alkaline mercerization liquors as-is after continuous recirculation or further enriched by extra added carbohydrates. At lower temperatures, weaker solutions may be used to achieve a similar effect. Concentrations of mercerization agents may vary provided that the desired results are achieved. When using the preferred sodium hydroxide mercerization agents concentrations are typically greater than about 12%, preferably greater than about 14% and more preferably from about 15% to about 20%. Mercerization temperatures may vary provided that the desired results are achieved. When using the preferred sodium hydroxide mercerization agents temperatures are typically greater than about 20°C, preferably greater than about 23°C and more preferably from about 20°C to about 80°C.

While the treatment of the pulp with a mercerization solution is relatively independent of the slurry consistency, lower consistencies may require more basic mercerization solution in order to maintain the desired concentration. Furthermore, slurry consistencies of about 30 wt. % or higher may require more elaborate mixing techniques in order to assure adequate contact between the wood fibers in the slurry and the strong base.

Required treatment times may vary provided that the desired mercerized fiber results. Treatment times are preferably relatively short, although treatment of the wood fibers with a strongly basic mercerization agent may be conducted for 10 hours or more if desired. Typically, the wood fibers are treated for a period of time from about 10 seconds to about 1 hour, more preferably from about 30 seconds to about 30 minutes and most preferably from about 1 minute to about 5 minutes. During treatment, the wood fibers and mercerization solution are admixed vigorously to assure adequate contact and reaction between the fibers and the basic solution.

Treatment of the wood fibers may be conducted under atmospheric, sub-atmospheric or super-atmospheric conditions. For ease of equipment design and operation, atmospheric conditions are most preferred.

The mercerized fibers of this invention can be used for all purposes for which mercerized and conventional pulp fibers are used. For example, these fibers either alone or in physical admixture with conventional pulp fiber or cross linked with such conventional pulp fibers as described in greater detail in US Published Patent Application 2004/0177935 can be used to form fibrous webs using conventional processes and apparatus. See for example processes and apparatus described in “Handbook For Pulp & Paper Technologies”, 2nd Edition, G. A. Smook, Angus Wilde Publications (1992) and references cited therein. Preferably these fibrous webs are prepared by the process comprises: a) providing an aqueous pulp suspension; and b) sheeting and drying the aqueous pulp suspension to obtain dried paper or paperboard web or fibrous substrate.

In step a) of the preferred embodiment of this invention, an aqueous pulp suspension is provided. Methods of forming aqueous pulp suspensions are well known in the paper and paperboard art and will not be described in any great detail. See for example G. A. Smook referenced above and references cited therein. Any conventional aqueous pulp suspensions method can be used. The cellulosic fibrous component of the furnish is suitably of the chemically pulped variety, such as a bleached kraft pulp, although the invention is not believed to be limited to kraft pulps, and may also be used with good effect with other chemical pulps such as sulfite pulps, mechanical pulps such as ground wood pulps, and other pulp varieties and mixtures thereof such as chemical-mechanical and thermo-mechanical pulps. Recycled fibers and/or textiles residues are also suitable fibrous resources.

While not essential to the invention, the pulp is preferably bleached to remove lignins and to achieve a desired pulp brightness according to one or more bleaching treatments known in the art including, for example, elemental chlorine-based bleaching sequences, chlorine dioxide-based bleaching sequences, chlorine-free bleaching sequences, elemental chlorine-free bleaching sequences, and combinations or variations of stages of any of the foregoing and other bleaching related sequences and stages. After bleaching is completed and the pulp is washed and screened, it is generally subjected to one or more refining steps.

In step (b) of the process of this invention, the pulp suspension of step (a) is sheeted and dried to obtain dried paper or paperboard web. Methods and apparatuses for sheeting and drying a pulp suspension are well known in the
paper and paperboard art. See for example G. A. Smook referenced above and references cited therein. Any conventional sheeting and drying method can be used. Consequently, these methods will not be described herein in any great detail. By way of example, the aqueous paper making stock furnish containing pulp, and other additives is deposited from the head box of a suitable paper making machine into a single or multi-ply web on a papermaking machine such as a Fourdriner machine or any other suitable papermaking machine known in the art, as well as those which may become known in the future. For example, a so-called “slice” of furnish consisting of a relatively low consistency aqueous slurry of the pulp fibers along with the micro-spheres and various additives and fillers dispersed therein is ejected from a head box onto a porous endless moving forming sheet or wire where the liquid is dewatered by gradually drained through small openings in the wire by vacuum in the forming section until a mat of pulp fibers and the other materials is formed on the wire. The dewatered wet mat or web is transferred from the forming section to the press section on specially constructed felts through a series of roll press nips that removes water and consolidates the wet web of paper. The web is then passed to an initial dryer section to remove most of the retained moisture and further consolidate the fibers in the web having the desired caliper, density and basis weight.

[0024] Wet-laid webs or air-laid webs can be used for a variety of purposes. For example webs of this invention can be used for those purposes for which the porosity of the web is of benefit. For example, the fibers and webs of this invention can be used to make cigarette paper using conventional procedures as for example those described in greater detail in U.S. Pat. Nos. 6,722,889; 6,202,650, and 5,540,242.

[0025] For air-formed webs, the mercerized pulp can be shredded to form fluff pulp using conventional procedures as for example those described in greater detail in U.S. Pat. Nos. 5,536,369; 4,676,786, and 4,269,188. The fluff pulp can then be used in a variety of applications. The fibers and fluff pulp of this invention can be fabricated into absorbent webs using conventional processes as for example those used to form air laid, wet laid, carded wadths, spunbonded webs, needle-punched fabrics, hydroentangling, etc.

[0026] For example, these absorbent webs can be used to articles where the absorbent/porosity characteristics of the web and fibers of this invention are advantageous such as personal hygiene articles such as diapers, tampons, sanitary napkins, bibs and incontinent pads, surgical sponges, compresses, bandages, wipes. These articles and methods for their manufacture are described in more detail in U.S. Pat. Nos. 5,019,063; 6,063,982; and 5,766,159. For example, personal hygiene articles absorbent articles of this invention typically contain at least one fluid permeable top sheet layer, at least one fluid impervious back sheet layer cotermious with the top sheet layer and at least one absorbent sub layer between the top sheet layer and the back sheet layer. The absorbent sub layer of the present invention exhibits an Air Porosity equal to or greater than about 100 cfm/sq ft as determined by the procedure of TAPPI T251 cm-85 on 60 gsm hand sheets at a testing pressure of 125 Pa. Preferably the Air Porosity of the sub-layer is equal to or greater than about 110 cfm/sq ft. In the preferred embodiments of this invention, the fibrous web has Air Porosity equal to or greater than about 125 cfm/sq ft.

[0027] The absorbent sub layer typically contains from about 10 to about 100 wt. % of fluffed wood pulp of this invention. The absorbent layer preferably contains from about 20 to about 100 wt. % of the fluffed wood pulp, and most preferably about 50 wt. % fluffed wood pulp and about 50 wt. % unprocessed fiber. Optionally, the absorbent sub layer may be composed of from about 10 to about 90 wt. % of fluffed wood pulp and from about 10 to about 90 wt. % of super-absorbing polymers in the form of grains, powders, small fillments or other forms. Super-absorbing polymers may be admixed with the fluffed wood pulp or they may be placed in a separate absorbent layer above or below the fluffed wood pulp layer to form a composite absorbent sub layer.

[0028] Both the fluid permeable material and the fluid impervious material, when used, are well known to those of ordinary skill. Accordingly, the top sheet layer may be made from a wide range of materials, such as porous foams, reticulated foams, apertured plastic films, natural fibers (e.g., wood or cotton fibers), synthetic fibers (e.g., polyester or polyethylene fibers) or from a combination of natural and synthetic fibers. Preferably, the fluid permeable material is a hydrophobic material that will effectively isolate the wearer’s skin from fluids in the absorbent sub layer. The fluid permeable material in the top sheet layer may be treated with a surfactant in order to facilitate penetration of fluid through the layer, recognizing, of course, that the top sheet layer should remain relatively hydrophobic as compared to the absorbent sub layer. Laminated with a top sheet formed from a flexible, fluid permeable material thereby forming the personal hygiene article. In a particularly preferred embodiment, a second surface of the sub layer is laminated with a back sheet formed from a fluid impervious material so that the absorbent sub layer is between the top sheet layer and the back sheet layer. The back sheet layer is preferably made from a thin plastic polyolefin film that is relatively impervious to fluids. Accordingly, the back sheet layer is selected from a material which effectively prevents fluids absorbed by the absorbent sub layer from wetting articles of clothing and the like which contact the personal hygiene article. Preferably, the back sheet layer is a polyethylene film having a thickness of from about 0.012 mm to about 0.051 centimeters. However, any commercially available fluid impervious material having suitable flexibility may be used to make the back sheet layer.

[0029] The fibers and fluff pulp of this invention can be fabricated into filter webs using conventional processes as well known in the art. For example, these filter webs can be used to produce articles where the porosity characteristics of the web and fibers of this invention are advantageous such as air filters and oil filters. Such filters are well known in the art and will not be described in any detail.

[0030] The present invention will be described with references to the following examples. The examples are intended to be illustrative and the invention is not limited to the materials, conditions, or process parameters set forth in the example.

**EXAMPLE 1**

[0031] In this process, standard Southern pine bleached Kraft pulp (unrefined, IP-Georgetown mill) is treated with 15% Sodium Hydroxide, at room temperature for 5-7 min-
mates. The fluff pulp is washed and thickened. Sheets are made at about 750 grams per square meter, dried to about 7% moisture and tested. Using this process to produce pulp for absorbent product applications is disclosed in U.S. Pat. Nos. 5,766,159 and 6,063,983 incorporated herein by reference as if fully set forth. Previously, quality tests on the pulp did not include porosity or other properties such as kink and curl because these methods were not available. Three caustic concentrations (5, 10 and 15%) were chosen for the fiber treatment. Microscopic observations of the fibers revealed that the 15% fiber treatment provided differences in the shape of the fibers, in terms of curl and entanglement. Fiber Quality Analysis is used to get values for the entanglement.

Fiber Quality Analysis — Kink and Curl

The Fiber Quality Analysis (FQA) provides measurements of length, width, kink and curl of fibers in suspension. This analysis is performed in Fiber Analyzer Equipment, which has a cytometric flow cell where the fibers pass through. The entire sample is drawn from a beaker and a high-resolution camera captures images of individual fibers. Circular polarized light is used for the measurements described below:

a) Fiber length: is described as either the contour length (L) or the end-to-end projected length (l). See FIG. 3

b) Curl: is the gradual and continuous curvature of a fiber and is defined by Curl index:

Curl Index = (L/l) - 1

c) Kink: is the abrupt change in the fiber curvature and is defined by Kibblewhite’s Kink Index. The modified kink index is the weighted sum of the number N_k of kinks within a range of “x” kink angles.

Kink Index = \[ \frac{1}{2} \sum_{x=1}^{N_{kink}} (N_{kink} - x)^2 \]

The sample was compared to a non-treated pulp as well as one available commercial pulp (“curly fiber” HBA pulp, Weyerhaeuser) and showed the following differences:

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Fiber length, mm</th>
<th>Fiber length, mm Weighted</th>
<th>Curl Index</th>
<th>Kink Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>2.37</td>
<td>3.08</td>
<td>0.142</td>
<td>1.41</td>
</tr>
<tr>
<td>HBA</td>
<td>2.35</td>
<td>3.04</td>
<td>0.257</td>
<td>2.31</td>
</tr>
<tr>
<td>Mercerized</td>
<td>1.91</td>
<td>2.51</td>
<td>0.346</td>
<td>2.68</td>
</tr>
</tbody>
</table>

Based on the information from FQA and microscopy, absorption tests for fluff pulp were performed. However, these tests are complemented with physical measurements and realized that the mercerized pulp was too porous and went off scale in the conventional Tappi Gurley porometer.

The porosity of the pulp was determined by the following equipment: a) Capillary Flow Permeameter Results in Darcy Permeability Constant and Gurley Units; b) Cerulam PPM 100 Permeameter—Results expressed in Coresta Units.

Capillary Flow Permeameter

In this equipment, a sheet of paper or pulp is installed in a sample chamber and sealed using, a top and a bottom o-ring to prevent leakage through the sides of the sample. The sample diameter, thickness and desired test settings (like pressure drop, flow rate) are entered into the user-friendly software. The tests are started. Once the tests are completed, report software is used for data reduction and calculation of permeability values. Various models of permeameters can measure the permeability of a sample in Rayls, Gurley, Frazier and Darcy, as well as other units.

The Darcy’s Permeability Constant is calculated using equation:

\[ C = \frac{8FTV}{\pi D^2 (P^2 - 1)} \]

Where:

- C: Darcy’s Permeability Constant
- F: Flow
- T: Sample Thickness
- V: Gas Viscosity (table below)
- D: Sample diameter
- P: Pressure (atmospheres)

Table of Viscosity Values

<table>
<thead>
<tr>
<th>Gas/Liquid</th>
<th>Air</th>
<th>Argon</th>
<th>Helium</th>
<th>Nitrogen</th>
<th>Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity</td>
<td>0.0185</td>
<td>0.221</td>
<td>0.00918</td>
<td>0.0185</td>
<td>1</td>
</tr>
</tbody>
</table>

Our sample was compared to the available commercial samples and showed the following differences:

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Darcy Permeability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial</td>
<td>1.0258</td>
</tr>
<tr>
<td>Mercerized</td>
<td>7.2255</td>
</tr>
</tbody>
</table>

The Gurley number refers to the number of seconds required for passing 100 ml of air in the cylinder displacement. Our sample showed the following results:

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Average Gurley Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial</td>
<td>2.3628</td>
</tr>
<tr>
<td>Mercerized</td>
<td>1.6318</td>
</tr>
</tbody>
</table>

Cerulam PPM 100 Permeameter — Coresta Porosity Test

The equipment provides an accurate test for air permeability for most types of paper in the range 10-40,000 CORESTA units. Coresta is the acronym of Centre de
Cooperation pour les Recherches Scientifiques Relatives au Tabac, an international organization of representatives from the tobacco industry, sharing scientific/technical information relating to the tobacco plant as well as tobacco products.

The porosity of cigarette paper for example can be expressed in ml/min/cm2, the volume of air in ml (20°C, 760 torr, 55-65% RH) that passes through 1 cm² of a flat specimen of the paper in 1 minute when a negative pressure of 100 mm water column is applied to one side of the specimen. When analyzed by the Cerulean PPM 100 permameter, the sample exhibited the following results:

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Coresta Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial 1</td>
<td>461 C.U.</td>
</tr>
<tr>
<td>Commercial 2</td>
<td>503 C.U.</td>
</tr>
<tr>
<td>Mercerized</td>
<td>2705 C.U.</td>
</tr>
</tbody>
</table>

The test exhibits that the high porosity material can be used in cigarette papers, to allow dilution of nicotine during the air intake. Highly porous materials can also improve the performance of automotive filters or other filters in general. Another use of this ultra porous material could be in acoustic applications as a sound absorber. Our mercerized pulp can be used alone or in conjunction with other types of fibers (synthetic or not) to improve filtration performance.

Thus, the absorbent articles of the present invention contain pulp processed with chemicals commonly found in the industry. Furthermore, the chemicals used to form the fluffed pulp may be easily removed by simple water washing. Another advantage of the invention is that the improved absorbency pulp may be made with inexpensive chemicals using relatively short reaction times. The resulting fluffed wood pulp may be used without additives as an absorbent sub layer or it may be combined with other super-absorbing compounds and fibers for increased absorbency.

Although this specification discloses particular embodiments of the invention, these examples merely describe illustrations of the invention. Those skilled in the art may recognize numerous rearrangements, modifications and substitutions of the invention within the spirit and scope of the appended claims.

EXAMPLE 2

Air Permeability characteristic of several different commercial mercerized pulps against mercerized unrefined southern pine, bleached Kraft pulp of this invention where evaluated using the procedure of TAPPI T251 cm-85. The results are set forth in the following table 1.

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Air Perm. (cfm/sqft)</th>
<th>St. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial A (1)</td>
<td>95.3</td>
<td>4.4</td>
</tr>
<tr>
<td>Commercial A (2)</td>
<td>108</td>
<td>5.6</td>
</tr>
<tr>
<td>Commercial B (1)</td>
<td>108</td>
<td>10.9</td>
</tr>
<tr>
<td>Commercial B (2)</td>
<td>105</td>
<td>13.2</td>
</tr>
<tr>
<td>Pulp 1 of the present invention</td>
<td>127</td>
<td>3.8</td>
</tr>
<tr>
<td>Pulp 2 of the present invention</td>
<td>150</td>
<td>11.6</td>
</tr>
<tr>
<td>Pulp 3 of the present invention</td>
<td>125</td>
<td>6.2</td>
</tr>
</tbody>
</table>

Testing was performed by using an FX 3300 tester according to TAPPI standard T251 cm-85 (specimens of 60 gsm, at 125 Pa testing pressure).

EXAMPLE 3

It was found that samples of bleached, unrefined southern pine Kraft pulps were mercerized under the conditions mentioned above using fresh alkaline liquor or reused alkaline liquors. After the standard reaction time, the pulps were washed with water, dried and tested for Air Permeability. The table 2 below depicts the improvement in porosity form the initial conditions (fresh liquor, depleted of dissolved hemicelluloses) and the same fibers after mercerization with an alkaline liquor that was reused 2 or 3 times.

<table>
<thead>
<tr>
<th>Reuses</th>
<th>Air Perm.</th>
<th>St. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>108</td>
<td>5.6</td>
</tr>
<tr>
<td>2</td>
<td>121</td>
<td>5.3</td>
</tr>
<tr>
<td>3</td>
<td>129</td>
<td>3.8</td>
</tr>
</tbody>
</table>

Testing was performed by IPS (Appleton-WI) using an FX 3300 tester according to TAPPI standard T251 cm-85 (specimens of 60 gsm, at 125 Pa testing pressure).

What is claimed is:

1. A mercerized cellulose fiber that forms fibrous webs that exhibit an Air Porosity equal to or greater than about 110 cfm/sq ft as determined by the procedure of TAPPI T251 cm-85 on 60 gsm handsheets at a pressure of 125 Pa.

2. A fibrous web comprising a plurality of mercerized cellulose fibers, said fibrous web exhibiting Air Porosity equal to or greater than about 110 cfm/sq ft as determined by the procedure of TAPPI T251 cm-85 on 60 gsm handsheets at a pressure of 125 Pa.

3. An article of manufacture comprising a body all or a portion of which comprises a fibrous web exhibiting an Air Porosity equal to or greater than about 110 cfm/sq ft as determined by the procedure of TAPPI T251 cm-85 on 60 gsm handsheets at a pressure of 125 Pa.

4. A process for forming the mercerized fibers which comprising treating cellulose fibers with a mercerization agent rich in dissolved hemicelluloses built up after continuous recirculation of the alkaline liquors or by extra addition of soluble carbohydrates, at an alkaline concentration of from about 5 wt. % to about 15 wt. % (based on the total weight of the mixture) at temperature and for a time sufficient to form mercerized cellulose fibers which form fibrous webs that exhibit an Air Porosity equal to or greater than about 100 cfm/sq ft as determined by the procedure of TAPPI T251 cm-85 on 60 gsm handsheets at a pressure of 125 Pa.