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[54] **FIBROUS SHEET MATERIALS AND FILTER ELEMENTS FORMED THEREFROM**

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[57] **ABSTRACT**

The invention relates to fibrous sheet material comprising an absorbent, paper-like cellulose wadding in sheet form having an array of substantially aligned fibres bonded to one side thereof. The fibrous sheet material may be creped or corrugated. The fibres are heat bondable and are bonded to the cellulose wadding by a treatment comprising a heat treatment. The fibres may be bicomponent fibres wherein one component is a heat bondable component. The fibrous sheet material is compressible into rod-like filter elements which are particularly applicable as cigarette filters.

3 Claims, No Drawings

FIBROUS SHEET MATERIALS AND FILTER ELEMENTS FORMED THEREFROM

The present invention relates to fibrous sheet materials, to filter elements formed from such fibrous sheet materials, and to a method for the production of such filter elements. Particularly, though not exclusively, the invention is concerned with filter elements for cigarettes and the like.

It is known to produce cigarette filter elements from creped or corrugated absorbent paper which is compressed into the desired shape by passage through a tubular die. Filter elements produced in this manner using so-called "Myria" paper are described in U.K. Patent Specifications 790,694 and 796,679. Furthermore, it is known to produce cigarette filter elements by contacting absorbent cellulose fibres with a corrugated paper, see for example, U.K. Patent Specification 639,919.

A deficiency of such filters is that they have an insufficient "wet hardness," that is they become soft when moistened; this interferes with the performance of the filters.

According to the present invention, a fibrous sheet material comprises an absorbent, paper-like cellulose wadding in sheet form having an array of substantially aligned fibres bonded thereto on one side thereof.

Preferably, the fibrous sheet material is creped or corrugated having "grooves" running longitudinally thereof.

Also according to the present invention, a fibrous sheet material comprises an absorbent, paper-like cellulose wadding in sheet form, which is uncalendered or has been only slightly calendered, having substantially parallel corrugations therein and extending longitudinally thereof, and an array of fibres bonded to one side of the paper-like cellulose wadding, the fibres extending in the direction of the corrugations and occupying at least some of the grooves formed thereby. Preferably, all the grooves are occupied by some of the fibres.

The invention further includes a rod-like filter element formed from fibrous sheet materials according to the invention.

Desirably, the absorbent, paper-like cellulose waddings used in the present invention exhibit the following properties:

i. Air permeability (ccs./cm^2/sec. at 1 cm. head of water)>100

ii. Bulk)ccs/gm)>4

iii. Substance (gms/metre^2)>20

iv. Ratio C/B>17

where

C = Compressibility (percent retained thickness, 135 gms. to 850 gms.)

B = Bulk (ccs/gm)

v. Product of Air Permeability and Compressibility > 500.

The properties serve to define cellulose waddings which used in the form of filter elements, especially for cigarettes, possess the optimum filtration efficiencies over the practical range of filter deniers.

The fibrous sheet materials of the invention are preferably made by contacting one side of an absorbent, paper-like cellulose wadding in sheet form with an array of substantially aligned fibres and subjecting the assembly to a bonding treatment whereby the fibres are bonded to the cellulose wadding. Continuously therewith or subsequently thereafter, the fibrous sheet material is formed into a rod-like filter element by compressing the fibrous sheet material during its passage through one or more suitably shaped dies or formers. The rod-like filter element is then subjected to a bonding treatment to provide additional bonding between the fibres and the cellulose wadding. If the bonding treatment is a heat treatment, then the die(s) or former(s) may be heated to effect the bonding during formations of the filter element. Preferably, the fibrous sheet material is corrugated before its passage through the die(s). This may be achieved, for example, by corrugating or creping the cellulose wadding before the application of the fibres thereto or by corrugating the fibrous sheet material i.e., the cellulose wadding/fibre assembly.

The fibrous sheet material is preferably formed into a rod-shaped filter element by feeding it into a conventional "Molins" rod making (cigarette filter) machine which compressed the fibrous sheet material into a cylindrical rod-shaped filter element of the required size. A wrapping paper may be fed into the machine as in conventional processes to maintain the shape of the filter element. The bonding treatment applied to the filter element improves the "wet hardness" of the filter element.

Desirably, the fibrous sheet materials and the filter elements made therefrom contain from 15 percent to 55 percent by weight of the fibres. A typical composition is 30 percent by weight of fibre and 70 percent by weight of cellulose wadding. Preferably, the fibres used in the invention are heat bondable fibres which are bonded to the cellulose wadding by heat treatments.

The heat bondable fibres may be staple fibres or continuous filaments and are rendered bondable at temperatures which have no deleterious effects on the cellulose waddings. Desirable fibres are those which comprise two or more components wherein at least one is a heat bondable component. Examples of such fibres are sheath/core conjugate fibres and side-by-side conjugate fibers. The preferred fibres are synthetic polymeric fibres which are undrawn and are essentially uncrimped. A typically desirable fibre array is composed of side-by-side, continuous conjugate filaments comprising 50 percent by weight of polypropylene and 50 percent by weight of polyethylene.

The shrinkage of the rod-shaped filter element should not exceed more than about 1 percent in length during the heat treatment applied thereto. For this purpose it is desirable that the fibre shrinkage should be as low as possible.

Although bonding of the fibres by heat treatment is preferred the use of a plasticiser/solvent treatment either alone or in combination with a heat treatment is envisaged.

The filter elements of the present invention are particularly suitable for cigarette filters. They have the advantages of increased "wet hardness", particularly useful for so-called "wet" smokers, desirable pressure drop i.e., readily allowing smoke to be drawn through, and high filtration efficiency. Although the filter elements of the invention are primarily designed for use as monofilters in view of their reduced cost, they may be used in conjunction with other filters in so-called duofilter systems.

Examples of filter elements made according to the present invention and their properties are listed in

Table I. The fibres used in each case consisted of side-by-side conjugate continuous filaments of 50 percent by weight polypropylene and of 50 percent by weight polyethylene. "D/C" denotes drawn and crimped filaments, and "S" denotes spun filaments i.e., undrawn and essentially uncrimped. A pressure drop of less than about 8 cms of water is required for a cigarette filter element to allow the smoker to draw easily on the cigarette. The filter elements of the invention given in Table I fit this requirement and also have a satisfactory high filtration efficiency.

Table II shows the pressure drop and filtration efficiency properties of three commercially available cigarette filter elements. A comparison with the monofilters in Table I shows that the examples of the invention have much higher filtration efficiencies than the monofilters of Table II and have filtration efficiencies substantially the same as that of the more expensive duo filter.

Table III shows that the "Myria" paper filter element has low wet hardness and that the cellulose acetate and the "Myria" paper/cellulose acetate duo-filter element have much higher values for wet hardness. The filter element made from 100 percent British Tissues cellulose wadding also has poor wet hardness. However, the examples of the invention in Table III have reasonably high wet hardness values.

The results given in Tables I, II and III are in respect of filters having lengths of 15 mm. and diameters 7.6 to 8 mm.

TABLE I

Type of paper-like material	Supplier	Weight of paper-like material (g./sq. meter)	Percent fiber	Type of* fiber	Composite+ denier	Pressure drop (cms. water)	Filtration efficiency (percent)
Single-ply bleached dry crepe cellulose wadding (uncalendered).	British Tissues Limited.	17	40	D/C	77,000	4.58	43.7
Do	do	17	30	D/C	82,500	6.55	49.3
Do	do	17	20	D/C	77,400	6.16	48.4
Do	do	17	30	S	81,400	5.64	47

TEST PROCEDURES

1. Bulk was measured in accordance with British Standard Specification 3983/1966.

2. Substance was measured by weighing 10 cm × 10 cm square samples and converting to gms/metre^2 by calculation.

3. Compressibility was tested by taking an additional thickness measurement according to the procedure in British Standard Specification 3983/1966 but using a load of 135 gms instead of 850 gms. It was then expressed as "Percentage retained thickness" by calculating as follows:

Thickness under 850 gms load/Thickness under 135 gms load × 100

4. Pressure drop is measured by mounting the sample in a holder connected to a supply of compressed air (8 pounds/inch^2). The rate of the air flow is monitored using a flow meter and the rate is adjusted to be 17.5 ccs/second. The pressure drop across the sample to maintain this flow rate is measured in centimetres of water.

5. Denier of rod-like filter element is given by the expression:

weight of 15 mm sample (gms) × 600,000. Denier of rod-like filter element at 8 mm diameter is given by the expression Denier × 8^2/(Rod diameter)^2 The rod diameter was measured using a Molins gauge.

6. The hardness of the rod-like filter element is expressed as

percent Height retained = Mercer gauge reading (mm) × 100/Initial Diameter (mm)

The sample was subjected to a load of 300 gms in a Mercer thickness gauge and after 15 seconds the diameter was noted.

7. The air permeability of wadding samples were measured using a Shirley Air Permeability apparatus in a standard atmosphere of relative humidity 65 ± 2 percent and a temperature of 20 ± 2°C.

8. The filtration efficiency of a rod-like filter element for a cigarette was measured on a standard "cigarette-smoking" machine having a "puff" volume of 25 ml, a "puff" duration of 2 seconds and a "puff" frequency of one per minute. A cigarette (Players Medium) was lit at the first puff and the machine was run for 10 cycles. The cigarette smoke was drawn through a filter train (the machine drawing 25 ± 0.5 ml of air per cycle) comprising the filter rod of the invention and a glass fibre filter/screw top/and ring assembly.

The filtration efficiency is calculated by the expression

$$\frac{\text{Weight of dry tar collected by filter rod}}{\text{Weight of dry tar on glass fiber filter/screw top/ring assembly}} \times 100$$

TABLE II

Composition of rod-like filter element	Pressure drop (cms./water)	Filtration efficiency (percent)
"Myria" paper (monofilter)	1.7	26
Cellulose acetate (monofilter)	6.0	30
"Myria" paper/cellulose acetate (duo-filter	6.7	49

TABLE III

Composition of rod-like filter element	Denier	Dry hardness (percent)	Wet hardness (percent)
"Myria" paper	59,200	75.0	29.0
Cellulose acetate	64,000	89.4	73.7
"Myria" paper/cellulose acetate duofilter (mean)	69,000	82.3	59.1
100% British Tissues cellulose wadding	78,600	83.3	40.2
30% by wgt. bonded fibers, 70% by wgt. British Tissues cellulose wadding *before* heat treatment	82,500	81.2	50.7
Do., *after* heat treatment	82,500	87.2	59.9
20% by wgt. bonded fibers, 80% by wgt. British Tissues cellulose wadding after heat treatment	77,400	84.3	56.4

What we claim is:

1. A fibrous sheet material comprising 85 percent to 45 percent by weight of an absorbent, paper-like cellulosic wadding having substantially parallel corrugations therein and extending continuously longitudinally thereof, said wadding exhibiting the following physical properties throughout its structure:

i. Air permeability > 100

ii. Substance > 20

iii. Compressibility/Bulk > 17

iv. Air permeability × Compressibility > 500 and 15 percent to 55 percent by weight of an array of fibres extending in the direction of the corrugations and occupying the grooves formed thereby, said array of fibres comprising heat bondable fibres which have been bonded to the cellulose wadding by a heat treatment.

2. A rod-like filter element formed from a fibrous sheet material according to claim 1.

3. A fibrous sheet material according to claim 1 comprising 70 percent by weight of said wadding and 30 percent by weight of said array of fibres, wherein said fibres are synthetic polymeric conjugate fibres having at least one heat bondable component.

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