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FILTER MEDIA

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This application is a continuation-in-part of application Serial No. 266,769, filed January 16, 1952, now abandoned.

This invention relates to filter media, and more particularly to such media composed of at least two layers, a relatively more porous layer composed of a blend of crimped fibers and other fibers, and a less porous layer containing a major proportion of fine, relatively straight fibers, each surface of which media includes a bonded zone containing about 10 to 50 percent by weight of the total fibers thereof, leaving an unbonded intermediate zone of at least 10% by weight of such total fibers.

Various filter media have been proposed heretofore for the separation of solid material from fluid material, e. g., for the filtration of fresh milk. One such filter material contains about 15 percent of thin, kinky cotton and 85 percent of straight rayon fibers having a diameter of 0.0011 inch. Such materials are disadvantageous according to present day standards from the retention efficiency viewpoint. The art is confronted by the problem of providing economic and efficient filter media having adequate flow rate for practical purposes and improved efficiency and endurance properties.

The discoveries associated with the invention and relating to solution of the above problems, and the objects achieved in accordance with the invention as set forth herein include: the provision of a filter sheet of matted fibers of at least 1 mm. in length, and crimped fibers having at least three crimps and having a wave length and amplitude in the range of 0.01 to 0.33 inch comprising (a) a coarser top layer making up about 40 to 80 percent of the sheet and comprising 10 to 90 percent of crimped fibers of a fineness weight in the range of 2.8 to 28 micrograms per inch for a material having the density of cellulose and 90 to 10 percent of uncrimped fibers of a fineness weight of 2.8 to 28 micrograms per inch for such a material, and (b) a finer bottom layer making up 60 to 20 percent of the weight thereof comprising 0 to 50 percent of crimped fibers of a fineness weight in the range of 2.8 to 6 micrograms per inch for such a material and 100 to 50 percent of uncrimped fibers having a fineness weight in the range of 2.8 to 6 micrograms per inch for such a material, the sheet being surface-bonded with an adhesive bonding agent to provide two continuous zones therein, each of which zones is coextensive with one of the surfaces of the sheet and contains about 10 to 50 percent by weight of the total matted fibers of the sheet, the intermediate unbonded zone containing at least 10% by weight of said total fibers, the total weight of the sheet based on matted fibers being in the range of 1.5 to 3 ounces per square yard; the provision of such a sheet wherein the crimped fibers are of regenerated cellulose and the other fibers are of natural cellulose; the provision of such a sheet wherein the crimped wave lengths and amplitudes are in the range of 0.02 to 0.17 inch and the other fibers are cotton of 0.5 to 1.5 inch in length; the provision of such a sheet wherein the top layer makes up about 66 percent

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of the matted sheet and comprises about 50 percent of crimped fibers and the bottom layer is of cotton fibers of a fineness weight of 3 to 6 micrograms per inch; the provision of such a sheet wherein each bonded zone contains about 0.9 percent polyvinyl alcohol adhesive and the weight of the sheet based upon matted fibers is about two ounces per square yard; and other objects which will be apparent as details or embodiments of the invention are set forth hereinafter.

In order to facilitate a clear understanding of the invention, the following preferred specific embodiments are described in detail.

Example I

A composite filter sheet of matted, regenerated cellulose fibers and cotton comprising at least two layers, referred to as a top layer (a) and a bottom layer (b), is prepared by depositing the various layers of matted, regenerated cellulose and cotton in sequence starting with the bottom layer; e. g., by means of conventional carding machines, preferably in random or isotropic arrangement. The top layer (a) constitutes about 66 percent by weight of the two layers, and is composed of a blend of crimped rayon of about 1.6 inch staple length and about 5.5 denier (15.5 micrograms per inch actual fiber length) diameter, each fiber of which contains 6 to 15 crimps per inch (crimped basis) each crimp having an amplitude (height from mean) of about $\frac{1}{32}$ inch and a wave length of $\frac{1}{15}$ to $\frac{1}{6}$ inch; and cotton having a fineness of about 3 to 6 micrograms per inch (9.9 to 14 microns diameter average) and an average classer staple length of about 0.8 inch. The bottom layer thereof constitutes about 34 percent of the total weight and consists entirely of the above-described cotton.

If desired, the above combination sheet may be supported on a web of woven material, such as gauze, or the like, which may be set below layer (b).

The formed composite sheet (including gauze support, if added) is passed between two spaced horizontal rollers of a coating machine, each of which is wetted with an aqueous solution of polyvinyl alcohol adhesive of about 0.70 percent by weight concentration (preferably completely hydrolysed, soluble in hot water and insoluble in cold water, having a viscosity of 55 to 65 centipoises by the Hoesppler falling ball method with 4% water solution cooled to 20° C.). The total pickup of this solution is about 250 percent of the total weight of matted fibers (including that absorbed by both sides of the composite sheet). Equivalent means for coating or treating the sheet with such a liquid may be used.

The sheet is then dried, e. g., by passing through a hot air oven, and it may be cut into individual filter disks or units of desired size or shape.

There are two zones of matted fibers containing adhesive agent, one adjacent to each surface of the sheet, each containing about 16 to 33 percent of the total matted fibers in the sheet, and about 0.9 percent of polyvinyl alcohol based on the total weight of matted fibers. A typical sheet made in this manner contains about 2 ounces per square yard of matted fibers.

In tests under actual use conditions on a dairy farm, a filter disk of this type showed very good retention of solid impurities yielding a high quality of filtered fresh milk, and at the same time showed high filtration speed (amply sufficient for practical purposes). It also showed good wet-strength and endurance under such use conditions.

Comparative heretofore suggested filter disks containing 15 percent of thin, kinky cotton and 85 percent straight rayon fibers having a diameter of 0.0011 inch are referred to as Example A hereinafter.

These filter disks were tested by the following pro-

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cedure: The test disk is mounted in a standard milk strainer (e. g., a commercially available strainer) with the top layer facing up and a mixture of 0.2 gram of Alundum (crushed fused aluminum oxide, wet sieved to a particle size in the range of 74 to 88 microns) in 3 pints of water, is poured into the strainer, followed by two one-pint water washes, and the resulting filtrate is filtered again through a #42 Whatman filter paper. The latter is burned, leaving only the Alundum passed by the test disk, and this residue is weighed. The following results are typical.

Characteristic Tested	Example A	Example 1
Flow Rate (for passage of 3 pint pouring).....	3.0	4.0
Retention (percent of total sediment retained by test disk).....	21.9	84.3

It is clear from the foregoing results that the Example 1 filter of the invention shows an about 3 to 4 fold superiority as to retention over the comparative Example A filter, even if the Example 1 retention is multiplied by a factor of $\frac{3}{4}$ to give a basis of comparable flow rates, and similar crimped cellulose acetate sheets do also.

Example 2

A modified sheet of Example 1 is prepared wherein the top layer is made up of a first or upper sub-layer (30% by weight of total matted fiber) containing an intimate blend of 50% by weight of the crimped rayon of 15.5 micrograms per inch and 50% of the crimped rayon of 8.5 micrograms per inch, and a second sub-adjacent sub-layer (38% by weight of total matted fibers), containing an intimate blend of 25% of the crimped rayon of 8.5 micrograms per inch, 25% of the crimped rayon of 4.25 micrograms per inch, and 50% of an intimate blend of all the matted fibers of Example 1, in the proportions set forth therein (having an average fineness weight in the range of 5.0 to 6.0 micrograms per inch.

The bottom layer is similar to that of Example 1 and is similarly bonded. The top layer has about double the amount of bonding agent, e. g., 1.5 to 1.9% of the agent based on the total weight of the matted fibers. The resulting sheet contains about 2.13 ounces per square yard.

Filter disks of this type showed very good retention in actual use conditions on a dairy farm, yielding high quality filtered fresh milk, and a slight lower, but adequate filtration speed.

Comparable results to the foregoing may be achieved with various modifications thereof including the following. The fibers should be at least 1 mm. in length and preferably of a convenient length to be handled by conventional carding machines, including those which give an isotropic or random arrangement of the fibers. Also, the longer fibers tend to give products having better wet-strength. Of the natural cellulosic materials, the wood pulp fibers may be in the range of about 1 to 5 mm. in length, and the usual textile fibers may be in the range of about 1 to 5 cm. or more in length. There is no fixed upper limit for the fiber length, except, of course, the size can be handled on the carding or other machine, or the size of the finished material.

The fiber fineness is conveniently expressed in terms of micrograms per linear inch, as known in the art (as determined by weighing measured lengths of fibers or by using known instruments, e. g., a commercially available instrument) the actual equivalent average diameter may be determined from this value and the density of the fiber. Cellulosic materials are economically available in abundant supply, and are preferred for economic reasons. However, other known fibers may be used, e. g., synthetic, organic, and the like fibers, including mixtures of different fibers. The fiber fineness weight

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of the materials in the top layer may be in the range of 2.8 to 28 micrograms per inch for the crimped material on the basis of the density of cellulose and 2.8 to 28 micrograms per inch for the other fibers on such a basis; and the fibers in the bottom layer may have a fineness weight in the range of 2.8 to 6 micrograms per inch on such a basis.

The crimps in the fibers may be rough or irregular or regular in a roughly 2-dimensional zone or in a 3-dimensional zone. The wave lengths and amplitudes thereof each may be in the range of about 0.01 to 0.33 inch. The crimped fibers should have at least three crimps or wave-loops, and this will determine the minimum length thereof.

The coarser or more porous top layer constitutes about 40 to 80 percent of the total weight of the matted sheet and is made up of 10 to 90 percent of the crimped fibers and 90 to 10 percent of the other fibers. The bottom layer constitutes 60 to 20 percent of the total weight of the matted sheet and may contain 0 to 50 percent of the crimped fibers, the remainder being the other fibers.

Each of the surfaces of the sheet is bonded and each such bonded zone contains about 10 to 50 percent by weight of the total matted fibers of the sheet, the intermediate unbonded zone containing at least 10% by weight of such total fibers, and the weight of the sheet based on matted fibers is in the range of about 1.5 to 3 ounces per square yard.

The bonding agent should be soluble in a convenient solvent, but insoluble in the liquid which is being filtered, and may be selected from latices of synthetic rubber, polyvinyl chloride or acetate, or the like, or solutions of starch, dextrin, gum arabic, agar agar, sodium alginate, gelatin, casein, and the like; if desired, the starch and the like may be rendered more insoluble by treatment with an appropriate agent, such as urea-formaldehyde or melamine formaldehyde. Other filter layers may be included in the sheet, if desired, at any location.

In view of the foregoing disclosures, variations or modifications thereof will be apparent, and it is intended to include within the invention all such variations and modifications except as do not come within the scope of the appended claims.

We claim:

1. A filter sheet of matted regenerated cellulose fibers of about 1 to 2 inches in length and cotton comprising (a) a top layer containing about $\frac{3}{4}$ of the total weight of the non-woven fibrous sheet composed of an about 50-50 blend of crimped rayon having about 6 to 15 crimps per inch, of about $\frac{1}{16}$ inch staple length and about 5.5 denier, with cotton having a fineness weight of about 3 to 6 micrograms per inch, and (b) a bottom layer containing the remainder of the total weight of said sheet, said bottom layer containing substantially all cotton fibers of about 3 to 6 micrograms per inch, said sheet being bonded with an adhesive bonding agent, said bonding agent defining two continuous zones within said sheet co-extensive with the opposite external surfaces thereof, each of said adhesive containing zones containing $\frac{1}{6}$ to $\frac{1}{2}$ of the total fibers in the sheet, the weight of said sheet based on non-woven fibers being about 2 ounces per square yard.

2. A filter sheet of matted fibers of at least 1 mm. in length and crimped fibers having at least 3 crimps and of wave length and amplitude in the range of 0.01 to 0.33 inch comprising (a) a coarser top layer making up 40 to 80 percent of the total weight of the matted sheet, said layer comprising 10 to 90 percent of crimped fibers of a fineness weight in the range of 2.8 to 28 micrograms per inch for a material having the density of cellulose and 90 to 10 percent of uncrimped fibers of a fineness weight of 2.8 to 28 micrograms per inch for a material having the density of cellulose and (b) a finer bottom layer making up 60 to 20 percent of the total weight of the matted sheet, said layer comprising 0 to 50 percent

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of crimped fibers of a fineness weight in the range of 2.8 to 6.0 micrograms per inch for a material having the density of cellulose and 100 to 50 percent of uncrimped fibers having a fineness weight in the range of 2.8 to 6 micrograms per inch for a material having the density of cellulose, said sheet being bonded with an adhesive bonding agent defining two continuous zones within said sheet, each of said zones being co-extensive with one of the surfaces of said sheet and containing about 10 to 50 percent by weight of the total fibers of said sheet, the intermediate unbonded zone containing at least 10% by weight of said total fibers, the weight of said sheet based on matted fibers being in the range of 1.5 to 3 ounces per square yard.

3. A sheet of claim 2 wherein the crimped fibers are of regenerated cellulose and the other fibers are of natural cellulose.

4. A sheet of claim 3 wherein the crimped wave lengths and amplitudes are in the range of 0.02 to 0.17 inch and the other fibers are cotton of 0.5 to 1.5 inch in length.

5. A sheet of claim 4 wherein the top layer makes up about 66 percent of the matted sheet and comprises about 50 percent of crimped fibers and the bottom layer is of cotton fibers of a fineness weight of 3 to 6 micrograms per inch.

6. A sheet of claim 5 wherein the bonded zones each contain about 0.9 percent of polyvinyl alcohol adhesive and the weight of the sheet based on matted fibers is about 2 ounces per square yard.

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7. A sheet of claim 4 wherein the top layer comprises an upper sub-layer blend of crimped rayon of 50% by weight of 15.5 and 50% thereof of 8.5 micrograms per inch, and a subjacent lower sub-layer blend of 25% of crimped rayon of 8.5 and 25% of crimped rayon of 4.25 micrograms per inch and 50% of a blend of all the fibers in their respective proportions as set forth in claim 4, said upper sub-layer making up 30% by weight and said lower sub-layer making up 38% of the total matted fibers in said sheet.

8. A sheet of claim 7 wherein the top bonded zone contains about 1.5 to 1.9% of polyvinyl alcohol adhesive and the bottom bonded zone contains about 0.9% thereof, the weight of the sheet based on matted fibers being about 2.13 ounces per square yard.

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