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METHOD OF SPINNING FIBERS FROM A FLUID SUSPENSION

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ABSTRACT OF THE DISCLOSURE

A method for spinning fibers comprising providing a fluid body containing fibrous materials suspended therein such as wood pulp or cellulose acetate, rotating the body of fluid relative to an axis while maintaining the body substantially stationary with respect to the length of the axis, whereupon a coherent strand containing aligned and twisted fibers is formed.

This invention relates to a method of spinning fibers from a fluid suspension.

In the prior art when it has been attempted to spin fibers from a fluid suspension it has been believed necessary to rotate the fluid while conducting it through a conduit. It was believed that the flow of fluid through the conduit was necessary to provide longitudinal alignment of the suspended fibers whereby they could become entangled in a continuous longitudinal structure. Such prior art is exemplified by U.S. Patent No. 2,700,866 and U.S. Patent No. 2,972,221.

It is an object of the present invention to spin fibers from a body of fluid in which the fibers are suspended by providing rotation of said body relative to an axis while maintaining said body substantially stationary with respect to said axis whereby said fibers are concentrated along said axis in an aligned and twisted configuration. This sharply contrasts with the prior art wherein axial motion of the fluid was a necessary condition.

Further objects will appear from the detailed description and claims which herein follow.

According to one embodiment of the present invention, there is provided the method of spinning fibers comprising: suspending fibers in a fluid; containing said suspension as a body; providing rotation of said body relative to an axis, while maintaining said body substantially stationary with respect to the length of said axis, whereby said fibers are concentrated along said axis in an aligned and twisted configuration; withdrawing said aligned and twisted fibers from said axis; replenishing said suspension with fresh fibers to replace the fibers withdrawn and with fresh fluid to replace any lost fluid.

In accordance with another aspect of the present invention, said axis comprises a rotating member immersed in said body, said relative rotation being provided only by the rotation of said member.

In accordance with a still further aspect of the present invention, said relative rotation is provided by rotating said body and in a still further aspect the rotation of the body is provided by mechanical stirring.

In yet a further aspect of the present invention said relative rotation is provided by propagating a gravity vortex in said body by allowing fluid to escape from the center of the bottom of said body while maintaining the height and volume of said body substantially constant by replenishing said body with fresh fluid introduced to said body other than at the center of its bottom.

Conveniently, said fluid is a liquid and consequently the fibers as withdrawn from said body are wet with said

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liquid and are subjected to a drying step. Fresh liquid is introduced to said body to replace the liquid which is withdrawn with said fibers. For economic reasons, it is preferred that the liquid comprise water.

Any fibrous material may be used. Thus, the fibers may be comprised of secondary cellulose acetate having an acetyl value of about 50 to 58% but preferably the well-known secondary cellulose acetate of commerce having an acetyl value of about 53 to 55%, cellulose triacetate, i.e., acetylated cellulose having an acetyl value, calculated as combined acetic acid by weight, of at least 59% of a theoretical maximum of 62.5%, other cellulose esters such as cellulose propionate cellulose butyrate, cellulose acetate-propionate or cellulose acetate-butyrate and cellulose ethers such as ethyl or benzyl cellulose, and blends of such organic derivatives of cellulose with fibers of other materials such as regenerated cellulose, e.g., viscose rayon or cuprammonium rayon, polyamides such as nylon, e.g., the polyamide of hexamethylene diamine and adipic acid or of 6-aminocaproic acid, polyurethanes, acrylonitrile polymers and copolymers, polyesters such as polyethylene terephthalate, cotton and animal fibers such as wool, mohair and silk.

Particularly good results have been attained with fibers comprising wood pulp, rayon, cellulose acetate or copolymers of at least 45% by weight of vinylidene cyanide with an ethylenically unsaturated comonomer.

In the specification and claims the term "cellulose acetate" generically denotes both secondary cellulose acetate and cellulose triacetate.

An advantage of spinning fibers from a fluid suspension according to the present invention as contrasted with conventional spinning is that fibers of a substantially shorter average length may be spun according to the present method than can be spun according to conventional methods. Thus, according to the present invention, fibers having an average length of about one-eighth inch or less may be spun whereas the minimum average fiber length for conventional spinning is about one-half inch. The maximum average fiber lengths which can be spun, according to the present invention, are about one inch.

When wood fibers are spun from an aqueous suspension of wood pulp, it is found that the spinning is aided by the presence in the suspension of fibers other than wood fibers such as rayon fibers, cellulose acetate fibers or fibers of copolymers of at least 45% by weight of vinylidene cyanide with an ethylenically unsaturated comonomer; any other conventionally spinnable fiber will also suffice. With such fiber addition the wood pulp fibers can be spun more rapidly. Also, it is observed that the spun wood fiber structures tend to disintegrate upon reimmersion in water. It is found, however, that a resinification reaction (such as by reaction of maleic anhydride and diepoxides) on the surface of the wood fibers greatly reduces the tendency of the spun wood fiber structures to disintegrate.

The minimum weight concentration of fibers in the suspension necessary to obtain continuous spinning varies from fiber to fiber. However, generally it is found that a fiber concentration by weight of at least about 0.1 gram of fiber per litre of suspension is necessary to obtain continuous spinning. There is also a maximum concentration above which continuous spinning cannot be obtained. When the fiber concentration is too great, the fibers do not have enough freedom of motion to become mutually aligned and entangled in a strand and therefore continuous fiber structure cannot be formed. The maximum fiber concentration by weight varies somewhat from fiber to fiber but generally it is about 10 grams of fiber per litre of suspension.

Spinning may be facilitated and the strength of the fiber strands increased by the addition of thickening agents or adhesives to the suspension. However, the results are somewhat unpredictable and sometimes a negative rather than a positive result will be achieved by these additions. The introduction of ion exchange groups in the fibers to be suspended is generally found to have a positive effect due to an improvement in interfiber bonding. The fiber strands may be subjected to mechanical twisting as they are withdrawn from the suspension. Conventional twisting-collecting devices may be used such as the conventional down twisters or up twisters. Furthermore, in a subsequent operation, the fiber strand may be further compacted and strengthened by an additional twisting operation or treatment with resins, adhesives and other similar compositions with which conventionally spun fibers are often treated.

The exact configuration of the apparatus which is used is not critical. The suspension may be contained in substantially any container. In order to induce the accumulation of the fibers in a strand-like configuration along the center axis of the container any mechanical swirling or rotating technique may be used. Thus, for example, on a small scale, a beaker may contain the suspension and the beaker may be equipped with a conventional magnetic stirrer and on a larger scale the suspension may be contained in a tank equipped with a paddle stirrer. Or, the container may be rotated as a unit causing the suspension therein to swirl about. On the other hand, the suspension may be left undisturbed as a body and instead the member which is to gather the fibers from the suspension may be rotated at the center of the body of the suspension. Thus, for example, the member may be a simple hook on a shaft; the shaft is rotated and the hook revolves in the suspension gathering together a longitudinal structure of fibers; the hook may then itself be used to withdraw the fibers simply by being drawn up from the suspension or if it is desired to continuously create a longer fiber structure the end of the fiber structure created at the hook may be withdrawn from the hook while leaving the hook immersed in the suspension and said end may be fixed to another take up means such as a godet roll. Thus, the strand collects at the hook continuously and from the hook is withdrawn by a take up means. On the other hand, the member may simply be an end of a fibrous strand which is being collected.

It is found that particularly good results are achieved when a gravity vortex is created in the body of the suspension. This may be done simply by providing the container with an outlet at the center of its bottom. The flow of liquid therefrom creates a gravity vortex. The suspension may be continuously replenished thus maintaining the height and volume of the suspension in the container constant. At constant flow conditions the vortex is very stable and excellent accumulation and entanglement of fibers at the axis of the vortex is achieved.

It should be understood that the withdrawing of the fibers from the suspension is a simple mechanical matter. Thus, for example, on a small scale a pair of tweezers may be used to grasp the upper end of the freshly formed fiber strand in the suspension; then, for example, the end may be attached to a take up roll.

The following examples will further illustrate the present invention.

Example I

5.5 denier per filament 3 inch viscose rayon staple fiber is cut into approximately ½ inch fibers, 0.5 gram of which are then suspended in approximately 1 litre of water in a beaker. The suspension is swirled by hand with a spatula blade; along the axis of the vortex which is thus formed fibers from said suspension become concentrated in an aligned and twisted configuration. The blade is withdrawn and a tweezer is used to grasp said fibers at the center of the vortex beneath the surface of the suspension. In this

manner, there is slowly withdrawn from the suspension surface a strand of fibers several inches long.

The same operation is carried out using ¼ inch viscose rayon fibers.

Example II

Ion exchange fibers are made by cross-link carboxylating viscose rayon fibers; according to the method disclosed in U.S. Patent No. 3,017,237; the fibers have a cation exchange capacity of 0.58 milliequivalent per gram and are cut into ½ inch lengths. The fibers are suspended in water again at a concentration of 0.5 g./litre and formed into a strand with ease by swirling the suspension and withdrawing the strand at the center of the vortex.

The spun fiber structures made according to the present invention may be employed in all conventional textile applications. Furthermore, since fibers such as wood fibers can be spun by this technique whereas they cannot be spun by conventional techniques additional applications appear. Thus, for example, spun wood fibers may be used for backings of floor coverings, mats and the like.

The above detailed description is not meant to limit the scope of the present invention. Obvious variations and modifications are intended to be encompassed by the claims which follow.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A method of spinning fibers comprising: suspending fibers in a fluid; containing said suspension as a body; providing relative rotation of said body relative to an axis, while maintaining said body substantially stationary with respect to the length of said axis, whereby said fibers are concentrated along said axis in an aligned and twisted configuration; withdrawing said aligned and twisted fibers from said axis; replenishing said suspension with fresh fibers to replace the fibers withdrawn and with fresh fluid to replace any lost fluid.
2. The method defined in claim 1, wherein: said fluid is a liquid.
3. The method defined in claim 2, wherein: said withdrawn fibers are wet with said liquid and, consequently, are subjected to a drying step; and said fresh fluid is liquid which replaces the liquid withdrawn with said fibers.
4. The method defined in claim 3, wherein: said liquid comprises water.
5. The method defined in claim 3, wherein: said fibers have a length of from about ½ to 1 inch.
6. The method defined in claim 5, wherein: said fibers comprise wood pulp.
7. The method defined in claim 5, wherein: said fibers comprise rayon.
8. The method defined in claim 5, wherein: said fibers comprise cellulose acetate.
9. The method defined in claim 5, wherein: said fibers comprise copolymers of at least 45% by weight of vinylidene cyanide with an ethylenically unsaturated comonomer.
10. The method defined in claim 5, wherein: said fibers have been surface modified through reaction with maleic anhydride and diepoxides.
11. The method defined in claim 5, wherein: the concentration of said fibers suspended in said fluid is from about 0.1 to 10 grams of fiber per litre of fluid.
12. The method defined in claim 1, wherein: said axis comprises a rotating member immersed in said body, said relative rotation being provided only by the rotation of said member.
13. The method defined in claim 1, wherein: said relative rotation is provided by rotating said body.
14. The method defined in claim 13, wherein: said body is rotated by mechanical stirring.
15. The method defined in claim 13, wherein: said body is rotated by propagating a gravity vortex in said body by allowing fluid to escape from the center of the

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bottom of said body while maintaining the height and volume of said body substantially constant by replenishing said body with fresh fluid introduced to said body other than at the center of its bottom.

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