

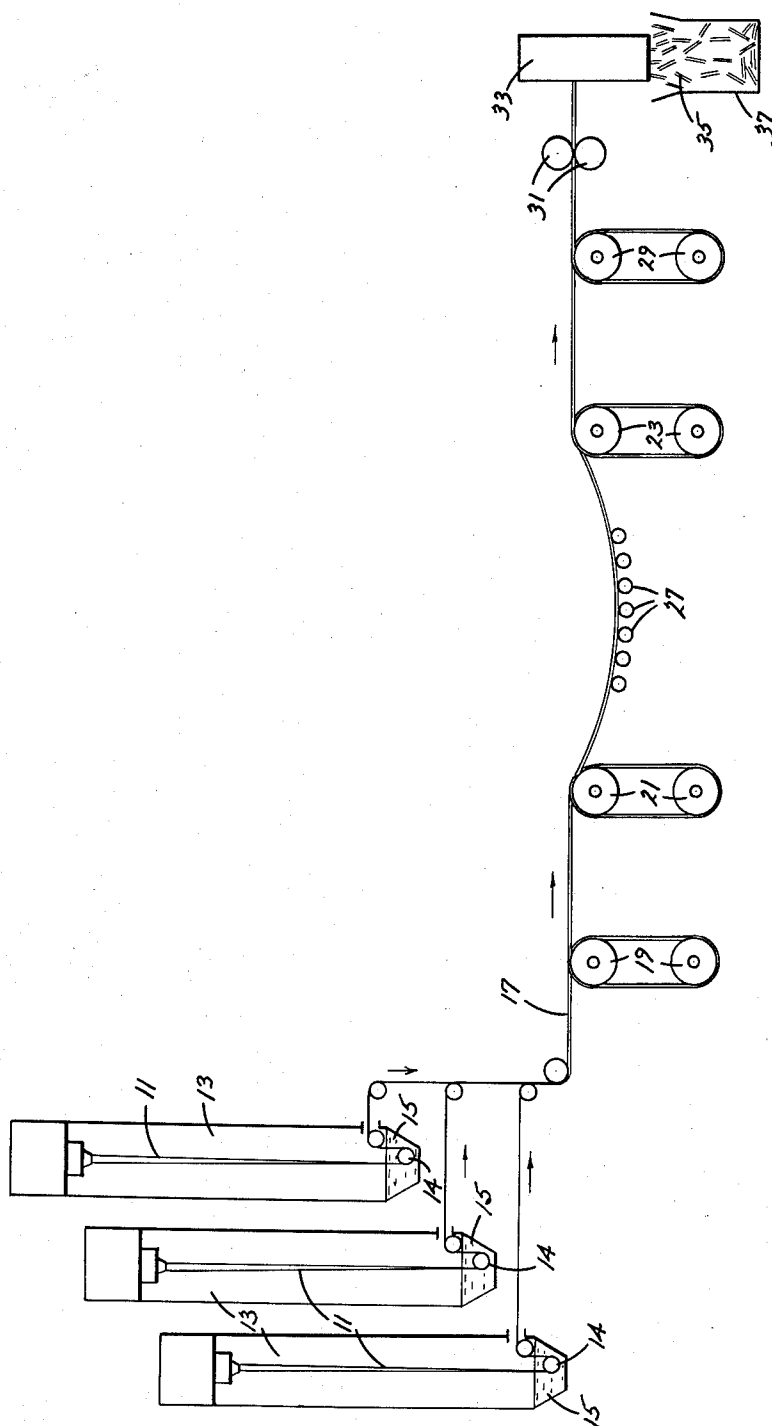
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METHOD OF PRODUCING STAPLE FIBERS

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The present invention relates to the production of synthetic fibers, and more particularly to staple fibers which are of good strength, are readily dispersible in fluids, and which exhibit similar shrinkage characteristics.

In the conventional manufacture of synthetic staple fibers, as for example from "Vinyon," a vinyl chloride-vinylacetate copolymer, filaments formed by an evaporative process in separate spinning cells are coated with a finish, either in the form of an oil or water emulsion, and then gathered into a single tow. At this stage the filaments are extremely plastic and generally contain from about 6 to 8% acetone and finish, as well as occluded water when an emulsion is employed, as based on the dry weight of the filaments. Once formed, the tow of filaments is cut into short sections, providing a mass of curled and tangled staple fibers generally of varied lengths. Such fibers are, of course, difficult to process and when placed in an aqueous medium, as for example in paper manufacture, they exhibit different shrinkage properties and poor dispersibility.

The unsatisfactory characteristics possessed by staple fibers produced by conventional methods have been attributed to a variety of factors, such as, the design and action of the staple cutter employed and/or the relatively high plasticity or solvent content of the tow during cutting. Changes in the construction and operation of the cutters has provided little improvement in the properties of the staple fibers produced. Attempts have been made to drastically reduce the solvent content of the tow, as by passing the same through a dryer. This course also has not proven to be entirely satisfactory and has often resulted in the formation of case-hardened filaments or filaments of such low plasticity as to render the staple fibers produced unsuitable for subsequent operations or intended uses. Accordingly, a primary object of this invention is to provide a generally new or improved and more satisfactory method for producing synthetic staple fibers having better properties than heretofore obtained.

Another object is the provision of a method wherein a tow of continuous synthetic filaments is conditioned to facilitate cutting of the same into staple fibers having good dispersibility and similar shrinkage characteristics in aqueous mediums.

Still another object is the provision of a method wherein a tow of synthetic filaments produced by conventional spinning procedures is relieved of uneven internal strains prior to cutting of the same to provide staple fibers having improved properties.

These and other objects and advantages will become more apparent from the following description and the accompanying drawing which diagrammatically illustrates the different steps of the method of the present invention.

In applying the method of the present invention to the production of "Vinyon" fibers the method includes, broadly, the steps of shaping of the "Vinyon" resin into filaments by conventional evaporative or wet spinning procedures, applying a finish to the shaped filaments and gathering the same into a single tow, relaxing the tow of filaments to permit the release of uneven internal strains from within the filaments, stretching of the tow after the relaxation thereof, and converting the tow, while under tension, into staple fibers.

Of particular significance is that prior to cutting, the

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tow of "Vinyon" filaments is relaxed and stretched, both steps of which are essential for the satisfactory practice of the method of the present invention. As heretofore mentioned, tow relaxation permits uneven strains, which are induced within the filaments during their formation, to be at least partially equalized or released to thus eliminate or at least minimize any tendency for the resulting "Vinyon" fibers to curl and tangle or entwine with each other, as occurs in conventional staple fiber manufacture. Generally, the rate at which such uneven strains are relieved will vary inversely with time, with the maximum release occurring during the initial stage of the relaxation period followed by a rapid leveling off to a somewhat uniform rate. Thus, relaxation of the tow of "Vinyon" filaments for as little as from 5 to 10 seconds will often provide sufficient release of such uneven internal strains as to render the resulting staple fibers more satisfactory for certain purposes than conventional "Vinyon" staple. On the other hand, the period of tow relaxation may be extended to as much as one week or more so that the relaxation period selected may well vary with the particular operating conditions and the ultimate use to which the staple fibers are to be applied. While considerable latitude exists as to the period during which the tow is maintained in a relaxed condition, the importance of this step of the method resides in the fact that even a relatively short period of relaxation provides for a large release of uneven internal strains and a remarkable improvement in the properties of the resulting staple fibers.

Tow relaxation may, of course, be effected in a variety of ways. In continuous operations; that is, where shaped "Vinyon" filaments are processed directly into staple fibers, the tow of filaments may be relaxed, for example, by (1) metering its rate of travel between pairs of spaced rolls or wheels so that the tow sags under its own weight, (2) plating the tow on an endless belt traveling slower than the rate at which the tow is delivered thereto, and (3) loosely wrapping a series of turns of the tow about a rotating cylinder. In all of the above-noted systems, different portions of the tow are being continuously advanced through different steps of the method, yet with the tow being permitted to assume a relaxed condition at a desired stage during its movement. Where more extended periods of tow relaxation are deemed necessary the tow may be delivered into a container, with its leading end being fed into a cutter after the tow has been stored in a relaxed condition for a desired period. Maximum tow relaxation may, of course, be achieved by storing the tow in a container for a relatively long period, as for example a week or more, as heretofore mentioned.

While the moisture and/or solvent content of the filaments is not critical for the satisfactory practice of the method described, some drying of the tow will be effected, by the surrounding atmosphere during the relaxation period. Under these mild conditions, however, there is little risk of case-hardening of the filaments or reducing their plasticity to such a degree as to render the resulting staple fibers unsuitable for further processing or certain desired end uses.

As heretofore mentioned, stretching of the "Vinyon" filaments after the relaxation thereof and maintaining the same under tension during their transfer to a cutter is critical for the satisfactory production of staple fibers having the desired characteristics mentioned above. Stretching, of course, effects orientation of the molecules within the filaments and thereby provides the resulting staple fibers with improved strength. Additionally, maintaining the tow of filaments under the influence of a stretching or tension force during cutting provides proper

linearity to the filaments and thus assures production of staple fibers which are substantially uniform in length.

The degree of stretch applied to the relaxed filaments may, of course, be varied to suit particular operating conditions and to provide the resulting fibers with the strength properties desired. In the production of "Vinyon" staple fibers stretching of the tow of filaments from about 5 to 60%, and preferably from about 10 to 40%, has been found to be highly satisfactory. In addition, to the above described stretching step, it is preferred to also stretch the tow of "Vinyon" filaments immediately after the application of finish and before the relaxation thereof. The degree of stretch applied at this stage is preferably within the same range as set forth above, and is in addition to the normal or usual tensions applied to the filaments during their formation and travel through the spinning apparatus. By subjecting the tow of filaments to such preliminary stretching, it will be apparent that staple fibers of extremely high strength can be provided without resorting to the application of excessive stretching forces during the final stretching stage; that is, after tow relaxation. Thus, while a preliminary stretching of the tow of filaments is not essential for attaining the full advantage of the method of the present invention, such stretching step permits the use of lower stretching forces and less rigid control during the final stretching operation, and is therefore preferred in the manufacture of "Vinyon" staple fibers.

The "Vinyon" staple fibers produced in accordance with the present invention may be spun into yarns in the conventional manner and are particularly well adapted for use in non-woven fabric or paper manufacture. Generally, the staple fibers possess no tendency to curl or entwine with each other and are well open, fluffy fibers which are free of coalesced ends, regardless of the moisture and/or solvent content of the filaments during cutting. The fibers disperse readily when placed within a liquid medium, exhibit greater and more uniform shrinkage characteristics than conventional "Vinyon" staple fibers and are substantially uniform in length thus facilitating easier processing during subsequent stages.

With reference to the accompanying drawing for a more detailed description of the invention, "Vinyon" is shaped into filaments 11 of desired denier by conventional procedures employing, for example, dry spinning cells as indicated at 13. The bundle of shaped filaments from each spinning cell are each guided by a rod 14 into and through a finish bath 15 located at the bottom of each of the spinning cells 13, and are then gathered into a tow as shown at 17. In accordance with the preferred procedure, the tow 17 is passed over and around pairs of spaced godet wheels 19 and 21, the latter of which is driven at a more rapid speed than the wheels 19 to thus elongate or stretch the filaments from about 10 to 40%.

From the godet wheels 21, the tow of stretched filaments is permitted to sag and is then laced over and around godet wheels 23 which are rotated at the same speed as the wheels 21. During its travel between the pairs of godet wheels 21 and 23, the slackened tow is subjected to only the weight of the suspended filaments and is thus free to relieve itself of uneven internal strains. When relatively heavy tows are being processed, a series of idler rollers 27 may be positioned between a pair of godet wheels 21 and 23 to at least partially support the tow 17 as it sags, to assure proper relaxation of the tow without obstructing its free and continuous advancement.

Upon completion of the relaxation step, the tow 17 is passed over and around a pair of godet wheels 29 which are rotated at a faster speed than the godet wheels 23 to thereby induce further stretching and orientation of the filaments. In the manufacture of "Vinyon" staple fibers, the tow of filaments is preferably elongated or stretched from about 10 to 40% at this stage for satisfactory results. During the relaxation and the initial

final stretching steps of the method, the filaments will undergo some drying by the surrounding atmosphere. While such drying is not critical for the satisfactory practice of the method described, from the standpoint of more efficient processing, it is desirable that the solvent content of the filaments be reduced but without involving extreme drying conditions.

By means of driven rollers 31, the stretched tow is fed under tension to a conventional staple cutter 33 where it is severed into short sections 35 and collected in a container or hopper as indicated at 37.

The following examples are presented to further illustrate the operation and merits of the described method.

Example I

Each of 50 dry spinning cells was arranged to produce, by conventional procedures, a 300 denier bundle containing 100 "Vinyon" filaments (3 denier/filament). A finish was applied to each bundle at the base of its respective spinning cell after which the bundles were gathered into a single tow. Employing spaced pairs of godet wheels driven at different speeds the tow was elongated about 33% and then plaited into a large storage container where it was permitted to relax for a period of 20 minutes. A free end of the relaxed tow was then fed between spaced pairs of godet wheels driven at differential speeds to apply a further stretch of about 25% to the filaments. The tow was then severed by a conventional rotary cutter while under tension to provide fibers of $\frac{1}{8}$ inch in length. As compared with "Vinyon" staple fibers produced by conventional procedures, the fibers formed as described above were not entwined or tangled with each other, exhibited good dispersibility when placed in water and collected on a screen and were of greater strength than conventional "Vinyon" fibers.

Example II

Employing the apparatus as described in Example I, 50 bundles of 330 denier, 60 "Vinyon" filaments (5.5 denier/filament) were gathered into a single tow after the application of a finish thereto. By means of spaced pairs of driven godet wheels, the tow was stretched about 33% and then deposited on a slowly advancing endless belt where it remained in a relaxed condition for a period of about 10 minutes. The tow was then stretched 15% between pairs of spaced godet wheels after which it was delivered under tension to a conventional rotary cutter where it was cut into fibers of $\frac{1}{4}$ inch in length. These resulting staple fibers exhibit properties similar to those of the staple fibers described in Example I.

The "Vinyon" has been used for the sake of convenience. However, it is obvious and it is to be understood that the method may be applied satisfactorily to all of the filament-forming vinyl chloride copolymer resins, such as the vinyl chloride-vinyl acetate and vinyl chloride-acrylonitrile copolymers represented to resins marketed as "Vinyon." As employed in the claims, the term filament-forming vinyl chloride copolymers is intended to designate these types of synthetic resins. Further, since the method facilitates the production of high strength fibers which are free of substantial uneven internal strains it is thus generally suited for the production of fibers from other filament-forming materials.

It is to be understood that changes and variations may be made without departing from the spirit and scope of the invention as defined in the appended claims.

I claim:

1. A method for producing synthetic staple fibers including the steps of forming a tow comprised of a plurality of synthetic filaments, permitting the tow to relax to relieve uneven internal strains from the filaments thereof, said filaments being subjected at most to such tension as may be induced by the weight of the filaments themselves during the relaxation thereof, stretching the tow of filaments to effect molecular orientation thereof,

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and maintaining the two under tension while cutting the same into short lengths.

2. A method for producing synthetic staple fibers including the steps of forming a tow comprised of a plurality of synthetic filaments, stretching the tow to effect at least partial molecular orientation within the filaments thereof, relaxing the stretched tow to relieve the filaments of uneven internal strains which may develop therein during the formation thereof, said filaments being subjected at most to such tension as may be induced by the weight of the filaments themselves during the relaxation thereof, stretching the tow after relaxation thereof to effect further molecular orientation within the filaments, and maintaining the tow of filaments under tension while cutting the same into short lengths.

3. A method as defined in claim 2 wherein the tow of filaments is elongated from about 5 to 60% during at least one of said stretching steps.

4. A method as defined in claim 2 wherein the tow of filaments is elongated from about 5 to 60% during both of said stretching steps.

5. A method as defined in claim 2 wherein the tow of filaments is maintained in a relaxed condition for a period of at least 5 seconds.

6. A method for producing staple fibers including the steps of forming a tow comprised of a plurality of filaments of vinyl chloride copolymers, stretching the tow

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to effect at least partial molecular orientation within the filaments thereof, relaxing the stretched tow to relieve the filaments of uneven internal strains which may develop therein during the formation thereof, said filaments being subjected at most to such tension as may be induced by the weight of the filaments themselves during the relaxation thereof, stretching the tow after relaxation thereof to effect further molecular orientation within the filaments, and maintaining the tow of filaments under tension while cutting the same into short sections.

7. A method as defined in claim 6 wherein the tow of filaments is elongated from about 5 to 60% during at least one of said stretching steps.

8. A method as defined in claim 6 wherein the tow of filaments is elongated from about 5 to 60% during both of said stretching steps.

9. A method as defined in claim 8 wherein the tow of filaments is maintained in a relaxed condition for a period of at least 5 seconds.

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