This invention relates to a treated tow of cellulose ester continuous filaments. More particularly, this invention concerns a particular size tow which has been treated with certain sorbitan compounds and which is especially adapted for use in the production of improved tobacco smoke filters.

This application is a continuation in part of our earlier U.S. Patents, Serial Nos. 435,544, now U.S. Patent No. 2,900,988, dated August 25, 1959, and 699,204. In U.S. Patent No. 2,794,239 of June 4, 1957, we have described a cellulose acetate tow useful for making cigarette filters. Also, we have described in detail how said tow may be manufactured into the cigarette filters. We have described the functioning of such a filter in taking out nicotine, tar and the like components from tobacco smoke.

We have now discovered how tow of the aforementioned type may be substantially improved by making a certain size tow in a certain manner and by treating the tow with certain sorbitan compounds to render the tow more useful in making filters.

This invention has for one object to provide a treated cellulose ester tow particularly adaptable for use in the production of tobacco smoke filters. A special object is to provide a tow of a particular size and crimp that represents a substantial improvement over prior art towels for the making of filters. Another object is to provide a tow which permits the mixing of filters with less material which gives a removal and other properties equivalent to prior art filters or when of equal weight gives a higher removal and other advantages. Another object is to provide a cellulose acetate tow that has been treated with certain sorbitan compounds. Still another object is to provide a tow of the class described which is more compact and thereby permits a better package (bale) to be made with less entanglement of fibers. Another object is to provide a tow that is treated with a combination of certain sorbitan compounds whereby the aging factor is improved, the fiber-to-fiber friction is decreased, with the result that better blooming is obtained.

Tows of textile fibers have been known in the textile industry for a number of years. However, such textile tow is unsatisfactory as such as tobacco smoke filters. In our Patent No. 2,794,239 aforementioned we have described a tow comprised of cellulose acetate filaments having an acetyl content of 38–41%, said filaments being of about 3 to 16 denier per filament. The total denier of the aforesaid tow is within a range corresponding to about 80,000 to 160,000. This tow has a crimp of, for example, 4–15 crimps per inch.

We have now found that filters with improved filtering efficiency, or equivalent filtering efficiency but of less weight, can be produced from a tow generally similar to the aforementioned tow but prepared in a different manner and preferably treated differently. Also, we have found that lower denier per filament, such as about 2 D/F, may be used with our new specially treated tow.

Also we have found that a tow of a lower total denier may be used. In the present invention, and as disclosed in our Patent No. 2,794,239, we prefer that our new treated tow be crimped. Such crimping should be uniform and regular.

In the usual prior art crimped tow for textile use, "skips" are frequently observed. That is, a show of length of 5% to 8% of an inch appears on the tow without any crimp. Also the crimp may vary at least plus or minus two crimps from the average or nominal value.

This prior art variation may occur from length to length or it may be that the crimp will vary across the width of the tow. Also it is quite common to find tow with a higher crimp in the center of the tow band than on one or both edges.

In the case of tow for cigarette filters uniform crimp is of great importance. A long skip will cause a soft spot in the finished filter rod. Furthermore, in mechanical processes for converting tow to filters, as described in our above-identified earlier applications, the tow may be stretched close to its breaking point to open and bloom the filaments. This opening operation, which is used in making filters, is not entirely dependent upon ultimate strength but upon uniformity. The action is such that a stronger tow must be tensioned more than a weak one. Therefore, since the crimp affects the strength of the filaments it follows that a uniform crimp is a substantial prerequisite to uniform strength. Accordingly, when the crimp varies along the tow, low crimp areas are not properly bloomed or high crimp areas break. It depends on which crimp level has been used to adjust the machine which is being used to convert the tow into a filter. Likewise, variations in crimp across the tow affect the blooming and result in a filter rod which is fuzzy on the end.

Hence, in the preferred embodiments of the present invention we prefer to have uniform and regular crimp.

In accordance with the present invention, in order to prepare a treated tow we proceed as follows. A spinning composition of cellulose acetate having a 38–41% acetyl content in acetone or other suitable solvent is made up. If round or cloverleaf shaped filaments are desired, the spinning solution is spun in a manner described in H. G. Stone U.S. Patents Nos. 2,000,047 and 2,000,048 of May 7, 1935. If on the other hand filaments of a special cross section such as a Y cross section are desired, the solution may be spun in accordance with the method described in Raynolds et al. U.S. patent application Serial No. 400,564, now Patent No. 2,829,027, dated April 1, 1958.

In accordance with the preferred embodiment of the tow prepared hereunder, the filaments would be dry spun from high viscosity cellulose acetate through orifices of .005–.045 mm diameter at low draft. For example, using acetone solvent, the high viscosity ester is spun at about 55° C. at a draft of less than 1.8.

The filaments of whatever configuration, produced as aforesaid, after removal of solvent and setting up in a spinning cabinet are conducted out of the cabinet around a godet roll.

Prior to or beyond the godet roll the filaments are treated with the sorbitan compounds of the present invention. Preferably these sorbitan compounds are applied from a mineral oil environment. Our preferred composition comprises mineral oil 50–90%, sorbitan monolaurate 25–5%, polyoxyethylene sorbitan monolaurate 25–5%. The mineral oil is of a high grade as described in our parent application. The sorbitan compounds are of a pharmaceutical or edible grade.

We have found that the aforesaid combination of sorbitan compounds not only lubricates the tow filaments satisfactorily but imparts other advantages. The tow is more...
compact. The aging factor of the tow is improved. The fiber-to-fiber friction is decreased. The character of the crimp is improved. Most surprisingly, filters made from the tow of the present invention have a considerably enhanced efficiency and other improved properties.

In further detail, the yarn may be prepared and the aforementioned sorbitan compounds may be applied to the tow by several methods such as the following:

A. Cellulose acetate yarn is produced by a suitable dry spinning process as referred to above. Immediately after the yarn from one spinning cabinet is withdrawn therefrom and before it wraps the godet roll, it is passed across the surface of a rotating cylindrical applicator roll. The sorbitan composition is picked up on the roll by partial immersion in a trough containing the composition.

If desired a doctor blade can be used on the applicator roll to control the film thickness of the sorbitan liquid although generally the film thickness is sufficiently uniform to make this unnecessary. The thread of filaments is slightly deflected from a straight line by the roll, preferably no more than 3°. The amount of the sorbitan composition applied can be controlled by varying this arc of contact or preferably by varying the speed of the roll. The roll may be rotated so that the surface in contact with the thread moves in the same direction as the threads in the opposite direction. In either case the surface speed of the roll is much less than the linear speed of the thread. The roll speed is generally between 0.1 and 3.0% of the yarn speed. The roll is generally a ceramic although metals and other suitable materials may be used. Preferably the surface is roughened to insure the adherence of a good uniform film of the sorbitan composition. If desired, the thread may be guided to run in a suitable groove out in the roll, providing better opportunity for all the filaments in the thread to pick up the composition.

Another method of applying the sorbitan composition is to pass the thread across a wick which picks up composition from a reservoir by capillary action.

C. Still another method is to meter the required amount of sorbitan composition to the wick or to a surface from which the thread can pick it up.

After the filaments are suitably treated as just described to apply the sorbitan composition thereto, 5,000 to 40,000 of the filaments are formed into a tow and have imparted thereto the uniform and regular crimp referred to above. This may be accomplished as follows:

Generally the number of filaments and the size tow are such that it is not practical to produce the tow from a single large spinnerette and the preferred practice is to combine the threads from a number of spinning cabinets. 1000 to 5000 denier is an advantageous size to produce from a single cabinet so 15 to 100 cabinets are combined to form a composite tow of 20,000 to 70,000 denier. The spinning capacity of the cabinet and the arrangement of the cabinets will together determine the number which can readily be combined to form the desired tow. Since the linear speed of all cabinet threads should be the same, the godet rolls are driven from a common power source.

So that each cabinet will produce its proportionate share of the total diameter, each spinnerette is supplied spinning solution from its own metering pump and these are also driven from a common power unit. The godet rolls and metering pumps may both be driven by the same motor or separate power units may be used in which case they should be inter-connected, electrically, hydraulically, or mechanically.

The threads from the required number of cabinets are drawn together to form the tow which is fed to a stuffing box type crimper. The secure uniform crimp is, it is important that the tow be presented to the crimper as a flat band of uniform width and thickness. Variations cannot be tolerated and it is equally important that the band width as the tow enters the crimper be properly correlated to the width of the rolls. Too narrow a band causes low crimp on the edges. Too wide a band results in what is termed "crimper harsh." This occurs when a few filaments are trapped between the sides of the rolls and the side plates which form the stuffing box. The filaments are chewed up and pressed into small, flat flakes of the material from which the filaments were spun.

For a still further understanding of our invention, reference will be made to the following detailed examples which are set forth primarily for illustrating preferred embodiments.

EXAMPLE I

In accordance with this example a Y-yarn was produced by the method described in the aforesaid Raymonds et al application. A tow of this Y-yarn of a denier of 60,000 was passed in contact with an applicator roller, which applicator roller rotated in a bath of finishing agent which consisted of a 10% aqueous emulsion of a mixture of 60% sorbitan monopalmitate and 40% polyoxyethylene sorbitan monolaurate derivative. This was applied to give about 0.5% of the non-aqueous agent to the Y-yarn. The Y-yarn was then uniformly crimped to 8.0 crimps per inch using apparatus substantially as described above.

The crimped tow of Y-yarn of this example was then made into cigarette filters in accordance with the procedure of our Patent No. 2,794,239 and the resultant filters tested.

These tests indicated that these filters made with our improved tow were better for the following reasons: The mixture of sorbitan monopalmitate and castor oil derivative was superior to mineral oil as a fiber lubricant. It provided a better ratio of static to kinetic friction between the tow and the surfaces of the crimper stuffing box. This relationship, commonly called "slip-stick," has an effect on crimp uniformity. With a high slip-stick ratio, the tow column in the stuffing box moves intermittently. With a low slip-stick ratio the column of tow moves more uniformly. This more uniform movement of the tow column is easily seen as is the improved uniformity of crimp. In addition, this particular lubricant has a lower fiber-to-fiber friction than mineral oil which makes it easier to separate the crimped filaments, one from another.

EXAMPLE II

A tow was produced in the same manner as described above except that the finish applied was a 10% aqueous emulsion of an agent comprising 70% N.F. (National Formulary) quality mineral oil, 17% sorbitan monolaurate, and 13% polyoxyethylene sorbitan monolaurate. The tow was crimped as described above. This finish has advantages as follows: In crimping, the water applied to the tow has an anti-static and softening effect, making it easier to control the tow band and to crimp uniformly. It was observed that a lower stuffing box pressure was required for 8.0 crimps per inch than for tow treated with straight mineral oil. Furthermore, the uniform water content obtained by emulsion application resulted in uniform action in the stuffing box and thus, uniform crimp. The higher moisture content in the tow at the time of crimping produced a firm compact ribbon which could be conveyed to and packed in the bale with less disturbance to the ribbon. The compact tow produced a more dense bale. In filter processing, the compact tow ribbon withdrew better from the bale and ran smoothly, producing uniform filter rods. In addition, the monolaurates complemented the mineral oil, decreasing the fiber-to-fiber friction, resulting in a better bloomed tow.

EXAMPLE III

In accordance with this example a yarn of conventional cloverleaf cross section was produced as disclosed in H. G. Stone U.S. Patents Nos. 2,000,047 and 2,000,048 of May 7, 1935. The yarn end from each spinning cabinet was passed in contact with an applicator roller before being conducted around the godet roll. The applicator
roller rotated in a bath comprising a 4% aqueous emulsion of a mixture of 75% N.F. quality mineral oil having a viscosity of 85-95 SSU (Saybolt seconds Universal at 100°F.), 12.5% sorbitan monoleate, and 12.5% polyoxyethylene sorbitan monoleate. The aqueous emulsion was applied in such quantity as to deposit 0.35% of the non-aqueous component to the yarn. The yarn end from each spinning cabinet comprised a number of filaments having an individual size of 2 D/F. A sufficient number of these ends were combined to form a tow containing 32,000 filaments with a total denier of 64,000. The tow was crimped as described above. It was observed that the emulsion finish provided excellent control of the filaments, resulting in a crimped tow having uniform crimp and a compact character which permitted packaging in a bale without disarrangement of the crimped tow band. This resulted in a bale of high density. In processing into cigarette filters as described in our U.S. Patent No. 2,794,239, it was found that the compact tow band withdrew smoothly from the bale with little tendency for loose, stray filaments to entangle filaments from adjoining layers of tow. The reduced fiber-to-fiber friction resulting from the addition of the laurates to the mineral oil finish improved the opening or fluffing of the tow so that essentially no married fibers remained in the tow. This good opening permitted optimum banding of the tow for uniform application of plasticizer. The resulting filter rods were characterized by exceptionally good uniformity and appearance. They were uniformly firm due to even plasticizer application and to the absence of uncrimped sections. The ends of the rods had a smooth, square cut and exhibited a uniform, matte finish brought about by the absence of any bundles of unopened filaments. Laboratory tests disclosed an improvement in uniformity of weight, size and pressure drop (resistance to passage of gas at a standard rate).

EXAMPLE IV

In accordance with this example, the spinning solution used was of a somewhat different composition than that used in Example I and comprised the following: cellulose ester—27.00%, titanium dioxide—0.15%, water—1.55%, acetone—71.30%. Reasonable tolerances were permitted on the percentage of each component.

This solution was extruded through a spinnerette containing 0.04 mm. openings to obtain filaments made up of 600 filaments of 2.8 D/F per filament. This yarn was treated with a 10% aqueous emulsion of a composition containing 65% of white mineral oil having a viscosity of 125 Saybolt Universal seconds at 100°F., 20% sorbitan monoleate and 15% polyoxyethylene sorbitan monoleate.

The yarn thus treated was formed into a tow of 90,000 total denier, uniformly crimped as described and formed into filters. The improved efficiency of the filters made from tow treated with sorbitan compounds of the present invention as compared with mineral oil treated tow is shown in the following table:

<table>
<thead>
<tr>
<th>Comparative processing</th>
<th>Mineral Oil Lubricant Emulsion Lubricant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processing Strength</td>
<td>Fair</td>
</tr>
<tr>
<td>Bonding</td>
<td>Good</td>
</tr>
<tr>
<td>Flow</td>
<td>Good</td>
</tr>
<tr>
<td>Bloom</td>
<td>Good</td>
</tr>
<tr>
<td>Appearance of Crimp</td>
<td>Residual slippage, amaturing crimp level</td>
</tr>
</tbody>
</table>

EXAMPLE V

In accordance with this example relatively small denier per filament and small total denier tow was prepared. This tow was dry spun from an acetone solution of high viscosity cellulose acetate. The tow was treated with approximately 5% of sorbitan composition as described above. In more detail, this composition contained approximately 75% mineral oil and approximately 12.5% each of sorbitan monolaurate and polyoxyethylene sorbitan monolaurate.

Also, this tow was more highly crimped than that previously described. For example, in the preferred embodiment of operation of the present invention the 2.1 D/F, 44,400 T/D was crimped to 16 crimps per inch.

The tow was formed into cigarette filter elements using air opening of the tow in making the elements. The elements were tested.

The following table summarizes the results of this example:

<table>
<thead>
<tr>
<th>Tow Denier</th>
<th>2.1</th>
<th>1.2</th>
<th>0.6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetate Textile Viscosity</td>
<td>46,400</td>
<td>31,000</td>
<td>26,000</td>
</tr>
<tr>
<td>Spinning Viscosity at 50°C, poises</td>
<td>120</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>Diameter, mm</td>
<td>350-400</td>
<td>350-400</td>
<td>350-400</td>
</tr>
<tr>
<td>Filament Quality</td>
<td>0.04</td>
<td>0.08</td>
<td>0.08</td>
</tr>
<tr>
<td>Tip Pressure Drop</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td>Total Removal, percent</td>
<td>35</td>
<td>42</td>
<td>43</td>
</tr>
</tbody>
</table>

In the above table, the tow removal figures are the percentage reduction in tars in the mainstream smoke for a king-size cigarette consisting of a 70 mm. tobacco portion and a 15 mm. filter as compared to an 85 mm. unfiltered cigarette. The control and the filtered cigarettes were all smoked to the same butt length using apparatus and procedures known to the cigarette industry. The total denier of each filter tow was adjusted so that the draw of each type of tip was essentially constant as indicated.

It is believed that the foregoing data clearly indicates that the preferred tow in accordance with the present invention, particularly tow of less than 3 D/F, 30,000-50,000 T/D and 16 CPI represents a particularly useful tow for making tobacco smoke filter elements.

While in the above examples we have shown the use of compositions in the amount of 0.35%, our sorbitan composition may be applied in amounts ranging from 0.1% to 2.0%. The sorbitan compounds while preferably laurates may be other long chain acid derivatives such as polyoxyethylene sorbitan monooleate or polyoxyethylene sorbitan tristearate.

In the above examples we have shown the application of our new treating agent to tows of various total denier and denier per filament. Thus practically we have found that we may increase the representation of D/F or a T/D of 15,000-100,000. While the tow is preferably made from dry spin cellulose acetate having an acetyl content of 38 to 41%, the benefits of this invention may also be obtained on higher acetyl contents, say around 44% acetyl and on tow made by other methods.

Our new treating agent appears to improve all ranges of denier and down to 100,000 T/D rendering the tow more easily packed into bales and the like. However, in the preferred embodiment of this invention we prefer a tow which is made up of finer filaments, for example, not greater than 5 denier per filament and of a total denier not greater than 70,000. Tow such is preferably crimped not less than 12 crimps per inch. Such preferred tow is treated with the sorbitan composition in the amount of from .1 to 2%.

It is believed apparent from the foregoing that we have provided a new treated tow that carries a certain sorbitan composition not heretofore used on crimped tow for tobacco smoke filters. As established above the filters made from our improved treated tow are advantageous in several respects.

We claim:

1. An article of manufacture comprising an intermediate product for use in the manufacture of cigarette filter tip elements of which substantially all of the filaments are parallelized and coextensive, said intermediate product being a bale of substantially untwisted, elongated, crimped continuous filament tow of which the filaments...
in the aggregate are substantially parallel, said tow being principally comprised of filaments of unplasticized but plasticizable cellulose acetate, said filaments being about 0.6 to 16 denier per filament and the total denier of the tow being within the range corresponding to 15,000–100,000, the filaments making up the tow having at least 8 crimps per inch and the crimp being substantially uniform and free of skips, and the tow being characterized in that it carries a composition consisting essentially of mineral oil, sorbitan monolaurate and polyoxyethylene sorbitan monolaurate.

2. An article of manufacture in accordance with claim 1 wherein the tow is comprised of cellulose acetate having an acetyl content within the range of 38–44% and the composition carried by the tow consists essentially of 70–75% mineral oil, 12–17% sorbitan monolaurate and 10–15% polyoxyethylene sorbitan monolaurate.

3. An article of manufacture in accordance with claim 1 wherein the total denier of the tow is within the range of 20,000–70,000, the filaments of the tow are principally of a denier per filament of less than 3 and the tow is further characterized in that the filaments therein are characterized by having not less than 12 crimps per inch.

4. An article of manufacture comprising an intermediate product for use in the manufacture of tobacco smoke filter tip elements, said intermediate product being a package of a cellulose acetate tow of 30,000–50,000 total denier, the filaments therein being not greater than 3 denier per filament and the tow being characterized in that the filaments therein are crimped not less than 12 crimps per inch, the crimps being relatively uniform both lengthwise and across the tow, the tow carrying the composition essentially comprised of a substantial content of mineral oil, sorbitan monolaurate 12–17% and polyoxyethylene sorbitan monolaurate 10–15%.

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