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TOBACCO SMOKE FILTER CONTAINING POROUS NON-SIFTING POLYOLEFIN PARTICLES

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This invention relates to a tobacco smoke filtering material and elements thereof which are suitable for use in cigarettes, cigarette holders, pipes and cigar holders. More particularly this invention relates to cigarette filters made from continuous crimped cellulose acetate filaments in the form of a tow, the tow having a microporous polyolefin floc type of powder on its surface.

As is known, a wide variety of fibrous materials have been suggested as tobacco smoke filtering means to remove nicotine, tars and other undesired components of the tobacco smoke. Thus, materials as crepe paper, cotton and certain textile fibers have been proposed as filtering media. However, some fibrous materials have certain disadvantages either from the standpoint of their fabrication into filters or their undesirable effect on the taste of the smoke. For example, cotton and paper cannot be too conveniently processed by conventional cigarette machinery into a form that can be readily cut into filter tips and added to the end of a cigarette. Another disadvantage of tobacco smoke filters made from cotton or paper is that moisture is absorbed quite readily by the filter which makes the smoke too dry.

The use of certain textile fibers, and in particular filaments of cellulose ester, overcomes to a great extent the aforementioned fabrication difficulties encountered with cotton or crepe paper. That is, textile fibers can be manufactured in a form that is easily converted by reasonable conventional cigarette processing equipment into filter tips which can be used for tobacco smoke filtering purposes. Thus, for example, it is possible to orient a large number of cellulose acetate filaments into the form of a continuous band which is commonly known to the trade as a tow. Such tow can be plasticized, cut, and wrapped in cigarette paper to form filter rods with great rapidity on a filter make-up machine. These filter rods are then easily cut into tips of the desired length and placed on the ends of cigarettes.

While, as just mentioned, textile tow has certain advantages for manufacturing tobacco smoke filtering elements, in some instances the resultant filter has not possessed as much tar removal capabilities as desired. This is due in most part to the physical makeup of the filter elements per se. As is known, these filter elements are prepared from a structurally unitary rod-like mass of filaments with a wrapper encircling the mass, each filament of the mass being substantially co-extensive therewith. The filaments as a whole are orientated substantially longitudinally of the mass, but each of the individual filaments having a plurality of short portions thereof crimped into diverging and converging relationship to the main filament axis with a plurality of the filaments having surface solvation bonds to contiguous filaments at random points of contact.

Thus there is always the possibility in a filter element of this type that tar particles in the smoke will pass between the longitudinally aligned filaments. When this happens, obviously these tar particles are not removed by the filter element. It is true that random bonds produced between adjacent filaments by the application of plasticizer bonding agents to the tow help alleviate this condition. Also, it is true that incompleteness of filament orientation, and the degree of crimp given to the tow reduces this smoke channeling effect somewhat. Nevertheless, all of these conditions are still not sufficient to make the path of the smoke sufficiently complex so that a substantial improvement in the filter elements effectiveness for removing tar and nicotine particles is realized.

One method for making a more effective filter element from a crimped tow of cellulose acetate filaments involves the application of powdered additives to the opened tow during its continual conversion into filter elements. Rice starch, flour, pectin and other like materials have been proposed for use in spread out crimped cellulose acetate tow fibers prior to their conversion to filter elements. However, even though the incorporation of such finely divided additives onto the surface of the crimped filaments have been successful in improving the filtering efficiencies of these filter elements from the standpoint of increasing its capacity for removing nicotine and tar, it has given rise to other problems. One of the more troublesome of these problems is how to keep the finely-divided additives from sifting out of the filter element. As will be apparent this sifting out of the additives not only decreases the efficiency of the filter, but quite often these loose additives get into the smoker's mouth thereby creating a condition that will not be tolerated by the smoker.

In a effort to minimize this sifting out of finely-divided additives from a filter tow or element it has been proposed that some steps be taken to bond the additive directly to the tow or element. This approach usually involves the use of an adhesive-like material which not only adds to the expense of manufacturing tobacco smoke filter elements, but also greatly complicates the processing steps necessary for forming a suitable filter element. Furthermore since tobacco smoke filters are usually held in the smoker's mouth, or if a holder is employed even then the filter is near the smoker's mouth, it is apparent that many materials that are strong adhesive agents cannot be used because of appearance, taste, odor or other similar reasons. Also certain materials that have adhesive properties exhibit such adhesivensss at the onset that they present problems of gumming the filter making equipment and pluging the applicator equipment.

Therefore, it is apparent that the development of a finely-divided additive material that could be used to improve the filtering properties of a tobacco smoke filter without creating a sifting out problem or requiring the use of an adhesive type bonding material would represent a highly desirable step forward in the tobacco smoke filter art.

After extended investigation it has been found that such a non-sifting, adhesive free finely-divided additive can be produced which, when used in a tobacco smoke filter element, greatly improves the tar and nicotine removal capabilities of a filter element. This additive is formed from polyolefin particles in a flocculent or fibrous form. This flocculent polyolefin material has been found to adhere to the cellulose acetate filaments in the tow filter far more securely than does a polyelfin powder, or for that matter any other type of powdered material (i.e., starch, cellulose acetate, powdered cellulose, etc.). Thus the additive does not sift out of the filter even when it is vigorously tapped.

Therefore, an object of this invention is to disclose a new and improved type of additive to cellulose acetate tow for the purpose of improving its performance as a tobacco smoke filter.

Another object of this invention is to disclose an additive that will not sift out of a finished filter element even when the element does not contain a bonding-type plasticizer, a conventional solvent or a water base adhesive.

Yet another object of this invention is to provide a way of producing an additive containing cigarette filter

which does not require the use of an adhesive or other type of additive bonding material.

A further object of this invention is to disclose a textile tow type of cigarette filter containing polyolefin particles in a flocculent or fibrous form on its filament surfaces which show no tendency to sift out of the filter when it is tapped.

These and other objects and advantages of this invention will be more apparent upon reference to the following description, specific working examples, and appended claims.

As mentioned briefly hereinabove, numerous experiments have been conducted and a large group of various finely-divided materials have been tested in an effort to determine which ones are best suited for use as an additive in tobacco smoke filter elements. Many of these tested materials have proven to be beneficial in improving, for example, the tar and nicotine removal capabilities of the filter element. However, all prior known finely-divided additive materials have had one common undesirable characteristic; namely, they tend to sift out of the filter unless an adhesive or bonding agent is employed to secure them to the fibers of the filter element. Thus, it was a heretofore generally accepted conclusion that no finely-divided filter additive could be produced which would not have a tendency to sift out of a filter element when applied directly thereto without some bonding medium being employed.

It has been discovered, however, that a finely-divided additive material for cellulose acetate tobacco smoke filter elements can be produced which have no tendency to sift out when the filter element is violently jarred or tapped. This totally unexpected non-sifting property is restricted to a specific class of materials which have been found to have certain physical characteristics or configuration. Namely, this non-sifting property is peculiar to polyolefin particles in a flocculent or fibrous form that have from 50 to 90 percent void space formed therein. Furthermore, best results are obtained when the polyolefin floc is capable of passing through a 20 mesh (U.S.S.) but incapable of passing through a 120 mesh screen.

Unfortunately, the exact reason why porous polyolefin floc of this type will "adhere" to cellulose acetate filter tow while other like material will not is as yet not fully understood. However, it has been found that any process can be used to produce the porous polyolefin material which will yield a flocculent or fibrous form material having from 50 to 90 percent void space in its individual fibrous particles. One process by which this porous polyolefin floc material was obtained involved intimately mixing a polyethylene resin with various types of ordinary starch. The types of starch used can be varied depending on the size void or pore that is to be formed. For example, potato starch will give large pore diameter particles (over 12 microns) while corn starch will give pore diameter particles in the 10 to 12 micron range. Rice starch can be used when 1 to 2 micron pore diameter particles are desired. The starch is then hydrolyzed and "leached out" with hot water. The most effective material was made using 80 percent rice starch and 20 percent polyethylene. This mixture gave a porous floc material with 80 percent void space in the individual polyethylene particles.

The amount of the porous polyolefin floc material that must be added to a given cellulose acetate filter tow depends primarily on the desired performance of the filter and the denier per filament of the carrier tow. For example, 16 denier/filament fibers would require up to 50 percent by weight of the additive to give effective tobacco smoke filter elements with reasonable pressure drops. On the other hand, 2 or 3 denier/filament fibers would require only 10 percent by weight of the porous polyolefin floc additive to give an effective filter.

A further understanding of the invention will be had from a consideration of the following examples that may be used in actual commercial practice and are set forth to illustrate certain preferred embodiments.

EXAMPLE 1

A 5 denier per filament cellulose actate tow containing 10,000 filaments and having 15 crimps per inch was spread out to a width of 15 inches. The tow was then dusted with a porous polyethylene floc of 20 to 50 mesh size prepared in the above described manner and converted to 90 mm. paper wrapped filter rods. The completed filter rods contained 79 percent cellulose acetate fibers and 21 percent of the porous polyethylene floc. The filter rods were cut into 17 mm. tips and these tips were attached to a domestic brand of nonfilter king-size cigarettes which had been shortened by 17 mm. It was then observed that the porous polyethylene floc additive did not sift out of the filters when they were tapped.

In order to establish the efficiency of the tobacco smoke filters containing the porous polyethylene floc additive, the above prepared cigarettes were smoked on an analytical smoking machine similar to the one described by Mumpower et al. in Tobacco Science 5, 1961, on page 31. The amount of smoke solids or tar removed by the filters was determined by a photofluorometric method as described by McConnell et al. in Tobacco Science 4, 1960, on page 55. These tests revealed that the 17 mm. additive containing filter elements removed 53 percent of the smoke solids at a filter pressure drop of 2.7 inches of water. The filter pressure drop was measured on apparatus as described by Touey in Analytical Chemistry 27 (1955), on pages 1788–1790.

For purposes of comparison, filter rods without the porous polyethylene floc were prepared from 5 denier/filament cellulose acetate tow (10,000 filaments). These filter rods were cut into 17 mm. filter tips, attached to cigarettes, and evaluated for both tar removal and pressure drop as previously described. These tests revealed that the filters without the additive were capable of removing only 25 percent of the tar in the cigarette smoke at a pressure drop of 1.6 inches of water. Thus it can be seen from this set of experiments that the porous polyethylene floc can be incorporated into a cellulose acetate filter without the use of an adhesive or bonding agent. Furthermore, it should also be equally apparent that the presence of the porous polyolefin floc additive in the filter greatly enhances the tar and nicotine removal capabilities of the filter element.

EXAMPLE 2

A length of 3 denier/filament cellulose acetate tow containing 12,000 filaments and having 15 crimps per inch was spread out to a width of 15 inches. The tow was then dusted with 40 to 70 mesh porous polyethylene floc and converted to 90 mm. filter rods. The completed filter rods contained 83 percent cellulose acetate tow and 17 percent porous polyethylene floc by weight. The filter rods were cut into 17 mm. tips and these tips were attached to a domestic brand of nonfilter king-size cigarettes which has been shortened by 17 mm. It was observed that the additive did not sift out of the filter rods even when they were vigorously tapped.

The filter elements containing the porous polyethylene floc were evaluated for tar removal and pressure drop as described in Example 1. This evaluation showed that the 17 mm. filters removed 55 percent of the smoke solids found in the cigarette smoke at a pressure drop of 3.0 inches of water.

For purposes of comparison, filter rods without the porous polyethylene floc were prepared from 3 denier/filament cellulose actate tow containing 12,000 filaments. These filter rods were cut into 17 mm. filter tips, attached to cigarettes, and evaluated for both tar removal and pressure drop as previously described in Example 1. These tests revealed that the filters without the additive were capable of removing only 39 percent of the

tar in the cigarette smoke at a pressure drop of 2.0 inches of water. Therefore it is again seen that the porous polyethylene floc additive can be incorporated into a filter element without the use of an adhesive or bonding agent, and that the filtering properties of the element are greatly improved by the use of the additive.

EXAMPLE 3

A length of 5 denier/filament cellulose acetate tow containing 9,000 filaments was spread out to a width of 15 inches and sprayed with triacetin (6 percent based on the tow weight). The treated tow was then dusted with 80 to 120 mesh porous polyethylene floc and converted to 90 mm. filter rods as previously described. The finished filter rods contained 85 percent by weight cellulose actate tow and 15 percent by weight porous polyethylene floc additive. The filters after curing were firm and the additive would not sift out of the filters when they were tapped. Evaluation of these filters with cigarettes in the manner described in Example 1 revealed that they were capable of removing 50 percent of the tobacco smoke solids at a filter pressure drop of 2.7 inches.

EXAMPLE 4

A length of 5 denier/filament cellulose actate tow containing 10,000 filaments and having approximately 15 crimps per inch was spread out to a width of 15 inches. The tow was then dusted with a microporous polypropylene floc of 20 to 50 mesh and converted to 90 mm. paper wrapped filter rods. The completed filter rods which contained 75 percent cellulose actate fibers and 25 percent microporous polyethylene floc, were then cut into 17 mm. tips, and these were attached to a domestic brand of nonfilter king-size cigarettes which had been shortened by 17 mm. It was then observed that the additive did not sift out of the filter when they were vigorously tapped. These filter tipped cigarettes were then smoked and the amount of smoke solids or tar removed was determined in the manner previously described in Example 1. This evaluation revealed that these 17 mm. microporous polypropylene floc containing filters removed 55 percent of the smoke solids at a pressure drop of 2.6 inches of water.

From the foregoing description it is readily apparent that the additive containing tobacco smoke tow and filter of this invention offers numerous advantages over those filters previously known and used in the cigarette industry. For example, not only does the use of the porous polyolefin floc additives give a filter that can remove appreciably larger quantities of the solid particulates found in cigarette smoke, but no adhesive or binding agent is required to prevent the additive from sifting out of the filter. Thus, since no bonding material is required for holding the porous polyolefin floc additives in the filter tow, these additives can be easily dispersed throughout a tow without the use of expensive equipment. Therefore, this elimination of all bonding materials and special applicator equipment for placing and holding the porous polyolefin additives in a filter tow permits the over-all expense of producing the end product to be reduced to an absolute minimum.

This invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by the United States Letters Patent is:

1. A tobacco smoke filter adapted to remove tar and nicotine from tobacco smoke, said filter being comprised of a bundle of generally longitudinally extending synthetic filaments, said filaments carrying on their surface particles of a polyolefin material, substantially all of said polyolefin particles individually having from 40 to 90 percent void space therein, wherein there is no adhesive bonding between the particles and the filaments and a wrapper enclosing the periphery of said bundle, the filter being further characterized in that (*a*) the porous polyolefin material is in the form of flocculent or fibrous form and (*b*) the porous polyolefin material does not sift out of the filter when it is vigorously tapped.

2. A tobacco smoke filter according to claim 1 wherein the porous polyolefin material is between about 20 mesh screen and about 120 mesh screen in size.

3. A tobacco smoke filter according to claim 2 wherein the synthetic filaments are formed from cellulose acetate.

4. A tobacco smoke filter according to claim 3 wherein the porous polyolefin material is selected from the group consisting of polypropylene and polyethylene.

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