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3,605,759

FILTER FOR TOBACCO SMOKE

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9 Claims

ABSTRACT OF THE DISCLOSURE

A filter is provided for removing hydrogen cyanide from tobacco smoke by incorporating a synergistic mixture of additives in smoke filtering material. The novel additive combination comprises an alkaline metal bicarbonate, such as sodium or potassium bicarbonate, and a water soluble poly(oxyalkylene) compound. Suitable poly(oxyalkylene) compounds are the high molecular weight polyethylene glycols and adducts of ethylene oxide and an alcohol or alkylated phenol.

BACKGROUND OF THE INVENTION

This invention relates generally to improved tobacco smoke filters and more particularly to an improved filter for tobacco smoke containing a novel synergistic combination of chemical additives characterized by increased capacity for removal of hydrogen cyanide from tobacco smoke.

It is well known that various additives can be incorporated in cigarette filter media to remove certain undesirable constituents from the smoke that the filter media by itself will not remove. Thus, U.S. Patent 3,403,689 discloses applying a water soluble inorganic salt, such as, an alkaline metal phosphite or carbonate to paper adapted for use in tobacco smoke filters to render the filter element capable of removing hydrogen cyanide from the smoke. U.S. Patents 3,428,055, 3,426,763 and 3,428,056 disclose a similar use of such salts in connection with other types of filter media. Also, U.S. Patent 3,370,592 mentions that cigarette filters impregnated with a mild base, such as sodium bicarbonate, will remove a part of the acidic components from cigarette smoke.

Other undesirable ingredients, such as phenolic compounds, have been successfully removed from cigarette smoke by incorporating a liquid poly(oxyalkylene) compound in the filter media as taught by U. S. Patent 3,310,060. These compounds, while being very effective for removal of phenols in the smoke, do not remove hydrogen cyanide. Wax additives, such as the high molecular weight polyethylene glycols proposed in U.S. Patent 2,904,050 and resinous polymers of ethylene oxide disclosed in U.S. Patent 3,032,445, also have been employed in conjunction with cigarette filters.

While cigarette filters treated with many of the foregoing additives remove a certain amount of hydrogen cyanide from the smoke, they are not as effective as is desired where substantial removal of hydrogen cyanide is sought.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a tobacco smoke filter capable of significantly reducing the amount of objectionable ingredients found in tobacco smoke. A

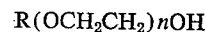
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specific object is to provide a cigarette filter treated with a novel combination of additives that is capable of removing substantially all of the hydrogen cyanide constituent in tobacco smoke.

After extended investigation, we have found an additive mixture that can be incorporated in conventional tobacco smoke filtering media, the ingredients of which act synergistically with each other to remove substantially all of the hydrogen cyanide from tobacco smoke. While the invention will be described with particular reference to removal of hydrogen cyanide, it has also been found that hydrogen sulphide as well as other undesirable ingredients found in tobacco smoke are significantly reduced. In accordance with this invention, filters treated with a combination of an alkaline metal bicarbonate and a poly(oxyalkylene) compound are characterized by a much greater affinity for hydrogen cyanide in tobacco smoke than when the bicarbonate additive is used alone. Whereas, the poly(oxyalkylene) compounds alone have little if any effect upon hydrogen cyanide reduction, they substantially improve the effectiveness of the alkaline metal bicarbonates toward hydrogen cyanide removal. Use of the synergistic combination of additives of this invention results in reductions of hydrogen cyanide as high as 100%, with simultaneous substantial reductions of hydrogen sulfide and many of the aldehydes in the smoke. The additives may be incorporated in the filter media separately or together during fabrication of the filters. So long as both are present together in the resulting filter, they act synergistically with each other to produce exceptional filtering characteristics for tobacco smoke.

The filter media material acts simply as a carrier or support for the additive combination and the particular material used is not critical. Typical of such filtering materials are paper, cellulose acetate fibers, rayon, cotton, nylon, etc. Cellulosic filter media is preferred because it will readily absorb the additives when they are applied thereto in a liquid solution.

Illustrative tobacco smoke filters, in accordance with the invention, comprise cellulosic filter media, impregnated with a mixture of sodium or potassium bicarbonate and a water soluble poly(oxyalkylene) compound. Very effective poly(oxyalkylene) compounds are those shown in U.S. Patent 3,310,060, the disclosure of said patent being incorporated herein by reference. Such compounds are liquid, have low volatility at ordinary temperatures (0° C. to 40° C.) and have a molecular structure corresponding to



wherein R is a monovalent hydrocarbon radical, chosen from the group consisting of alkyl and alkaryl containing 10 to 20 carbon atoms and n is a number between 5 and 15, representing the average number of moles of alkylene oxide combined with a mole of starting alcohol of phenol. Typical of such compounds are the adducts of monohydric alcohols or alkylated phenols containing 10 to 20 carbon atoms and ethylene oxide as set forth in greater detail in the aforementioned patent.

The polyoxyethylene sorbitan monolaurates containing up to 20 oxyethylene groups have also been used successfully in combination with alkaline metal bicarbonates.

Other poly(oxyalkylene) compounds that are very effective filter additives when used in combination with

alkaline metal bicarbonates are the high molecular weight polyethylene glycols (Carbowax). Particularly desirable polyethylene glycols have a molecular weight ranging from 300 to 500.

Obviously, there are many other poly(oxyalkylene) compounds which are useful and that will be suggested to those skilled in the art from the foregoing examples.

Cellulosic filters which are suitable for use in conjunction with the additives may consist of crepe or other absorbent paper, or of regenerated cellulose filaments or sponge assembled to form a plug providing tortuous passages to effect filtration of the tobacco smoke passing therethrough. Particularly preferred filters are those made of absorbent paper in accordance with the procedure disclosed in U.S. Patent 2,954,036 wherein the starting web of paper is moistened, longitudinally grooved between suitable rolls, dried to remove excess moisture and flattened to cause adjacent grooves to partly overlap each other. The thus treated web is then gathered into rods which are cut to desired filter lengths.

The additives are most effectively incorporated into paper filter media by dispersing them into a moistening liquid such as water and spraying the mixture onto the web. Alternately, other impregnating techniques may be used, such as immersion or roll coating. Similar methods may be employed where regenerated cellulose or other fiber tows are used as the supporting filter media. The additives may be incorporated into the filter media as a mixture in liquid solution, or individually if desired, the concentration of the additives in the moistening liquid being maintained at a desired level such that the resulting filter has an effective content of the additives. In the case of paper media, the web is dried after treatment to a low moisture content of about 3% to 6%, and made into filter rods. Particularly effective concentrations of additives in the filter range from about 3% to 20% by weight for the alkaline metal bicarbonate, and from 5% to 25% by weight for the poly(oxyalkylene) compound.

PREFERRED EMBODIMENTS

The results obtained in accordance with this invention are described in the following illustrative specific examples.

Example I

Cigarette filter rods of paper were made containing approximately 5% and 8% weight sodium bicarbonate in combination with 10% and 15% by weight nonylphenol polyglycol ether corresponding to the formula:



The additives were incorporated into the filter by treating the paper from which the filter was made with aqueous solutions of the additives in sufficient concentrations to achieve the specific percentages by weight in the paper.

Similar paper filter rods were also made containing approximately 5% and 7% potassium bicarbonate with 10% and 15% nonylphenol polyglycol ether.

The paper rods of approximately 24.6 mm. circumference were cut into filter tips of approximately 20 mm. length. All those treated were selected to have a pressure drop range of 1.7 to 2.2 inches of water. The filter tips selected were attached to regular commercial cigarettes 85 mm. in length. The cigarettes were conditioned at 72° F., and 62% humidity. In all cases, cigarettes within the weight range of .83 to .90 gram were used. The filter tip cigarettes were then tested in a standard analytical smoking apparatus in direct comparison with cigarettes from the same lot having: (a) identical paper filters but no additives, (b) identical paper filters containing either additive alone. The smoking machine was operated to take a 35 cc. puff of two seconds duration at the rate of one puff per minute. A Cambridge absolute filter pad which had been washed with 10% hydrochloric acid and followed by carbon tetrachloride washing and oven drying, was used to trap particular matter. Standard proce-

dures were used in determining percentage reductions of the constituent in the smoke. The following tables indicate the results obtained for hydrogen cyanide reductions using the various combinations of additives compared to either used alone or none at all.

TABLE I

Filter sample	Additive, percent by weight		Percent reduction of hydrogen cyanide
	NaHCO ₃	Nonylphenol polyglycol ether	
A-----	None	None	0
B-----	5	None	64.6
C-----	8	None	75.4
D-----	None	10	0
E-----	None	15	0
F-----	5	10	79.2
G-----	5	15	95.2
H-----	8	10	91.1
I-----	8	15	100

TABLE II

Filter sample	Additive, percent by weight		Percent reduction of hydrogen cyanide
	KHCO ₃	Nonylphenol polyglycol ether	
A---	None	None	0
B-----	5	None	68.1
C-----	7	None	74.3
D-----	None	10	0
E-----	None	15	0
F-----	5	10	95.5
G-----	5	15	98.8
H-----	7	10	98.1
I-----	7	15	95.1

As is evident from the foregoing comparative results, the filters containing the combination of additives in accordance with the invention markedly improve the reduction of hydrogen cyanide in cigarette smoke over filters containing either additive alone or none at all.

Example II

Another preferred combination of additives is sodium or potassium bicarbonate and polyethylene glycol, molecular weight 400 (Carbowax 400). The following tables indicate the results obtained using various combinations and percentages of these additives in paper cigarette filters treated and tested as described in Example I.

TABLE III

Filter Sample	Additive, percent by weight		Percent reduction of hydrogen cyanide
	NaHCO ₃	Polyethylene glycol, mol. wt. 400	
A-----	None	None	0
B-----	5	None	64.6
C-----	8	None	75.4
D-----	None	15	0
E-----	5	15	96.0
F-----	8	15	100.0

TABLE IV

Filter Sample	Additive, percent by weight		Percent reduction of hydrogen cyanide
	KHCO ₃	Polyethylene glycol, mol. wt. 400	
A-----	None	None	0
B-----	5	None	68.1
C-----	7	None	74.3
D-----	None	15	0
E-----	5	15	94.2
F-----	7	15	99.0

Here again, the unique synergistic effect resulting from the combination of additives in the filter removes substantially all of the hydrogen cyanide in the smoke. Thus, when higher percentages of additives are used in the filter, i.e., 15% polyethylene glycol with either 7% potassium bicarbonate or 8% sodium bicarbonate, 99 and 100 percent reductions, respectively, are obtained. It is seen that whereas the polyethoxylated compound additive has no effect on hydrogen cyanide removal by itself, when used

in combination with the alkaline metal bicarbonate it increases the effectiveness of the bicarbonate as much as twenty-five percent.

Example III

Further comparative data was obtained using additives of sodium or potassium bicarbonate with a polyethoxylated tridecyl alcohol represented by the formula:



Paper filters were treated with the additive combinations and tested according to the procedure described in Example I, and the following results were obtained.

TABLE V

Filter Sample	Additive, percent by weight		Percent reduction of hydrogen cyanide
	NaHCO ₃	Tridecyl alcohol polyglycol ether	
A.....	None	None	0
B.....	5	None	64.6
C.....	8	None	75.4
D.....	None	15	0
E.....	5	15	87.6
F.....	8	15	98.2

TABLE VI

Filter Sample	Additive, percent by weight		Percent reduction of hydrogen cyanide
	KHCO ₃	Tridecyl alcohol polyglycol ether	
A.....	None	None	0
B.....	5	None	68.1
C.....	7	None	74.3
D.....	None	15	0
E.....	5	15	94.6
F.....	7	15	93.5

Example IV

Another series of tests were run using a combination of potassium bicarbonate with a polyoxyethylene sorbitan monolaurate having about twenty oxyethylene groups.

The same procedures described in Example I were used to treat and test paper filters resulting in the following data.

TABLE VII

Filter sample	Additive, percent by weight		Percent reduction of hydrogen cyanide
	NaKCO ₃	Polyoxyethylene sorbitan monolaurate	
A.....	None	None	0
B.....	5	None	68.1
C.....	7	None	74.3
D.....	None	15	0
E.....	5	15	92.9
F.....	7	15	99.6

As the foregoing specific examples clearly show, it is essential that both additives be present in the filter to effect substantially complete removal of hydrogen cyanide from the cigarette smoke. While the alkaline metal bicarbonates by themselves are relatively effective toward hydrogen cyanide removal, this effectiveness is dramatically enhanced when such compounds are used in combination with the poly(oxyalkylene) compounds.

What is claimed is:

1. A tobacco smoke filter rod comprising a mass of filter material adapted to afford passage of smoke there-through, said material having uniformly distributed therein about 3% to 20% by weight of an alkaline metal bicarbonate selected from the group consisting of sodium bicarbonate and potassium bicarbonate and about 5% to 25% by weight of a normally water soluble poly(oxyalkylene) compound selected from the group consisting of polyethoxylated alcohols, polyethoxylated alkylphenols, and high molecular weight polyethylene glycols.

2. A filter according to claim 1, in which the alkaline metal bicarbonate is sodium bicarbonate.

3. A filter according to claim 1, in which the alkaline metal bicarbonate is potassium bicarbonate.

4. A filter according to claim 1, in which the poly(oxyalkylene) compound is nonylphenol polyglycol ether.

5. A filter according to claim 1, in which the poly(oxyalkylene) compound is a polyethylene glycol having a molecular weight from 300 to 500.

6. A filter according to claim 1, in which the poly(oxyalkylene) compound is tridecyl alcohol polyglycol ether.

7. A filter according to claim 1, in which the poly(oxyalkylene) compound is a polyoxyethylene sorbitan monolaurate.

8. A filter according to claim 1, in which the filter material is cellulosic filter media.

9. A filter according to claim 1, in which the filter material is paper.

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