

(19)



(11)

EP 3 939 444 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:

19.01.2022 Bulletin 2022/03

(51) International Patent Classification (IPC):

A24D 1/20 (2020.01)

A24D 3/06 (2006.01)

A24D 3/10 (2006.01)

A24D 3/14 (2006.01)

A24D 3/17 (2020.01)

(21) Application number: **21185285.0**

(22) Date of filing: **13.07.2021**

(52) Cooperative Patent Classification (CPC):

A24D 3/068; A24D 3/10; A24D 3/14; A24D 3/17

(84) Designated Contracting States:

**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

Designated Extension States:

BA ME

Designated Validation States:

KH MA MD TN

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(30) Priority: **14.07.2020 JP 2020120848**

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(54) **AEROSOL COOLING MEMBER**

(57) The purpose of the present invention is to provide an aerosol cooling member excelling in thermal stability, endothermic properties, and biodegradability. Accordingly, an aerosol cooling member containing cellulose acetate having a total degree of acetyl substitution of greater than 1.4 and not greater than 2.7 is provided.

EP 3 939 444 A1

Description

Technical Field

5 **[0001]** The present invention relates to an aerosol cooling member.

Background Art

10 **[0002]** There has been an increasing demand for Reduced Risk Products, which do not use fire, in place of regular cigarettes. Reduced Risk Products are generally divided into two types. The first is a type in which a solution obtained by dissolving nicotine in an organic solvent is heated, and the resulting aerosol or vapor is inhaled. The second is a type in which an aerosol containing nicotine that disperses upon the heating of tobacco leaves is inhaled. This type does not burn the tobacco leaves. Here, the tobacco leaves may be pseudo-tobacco leaves, product obtained by processing tobacco leaves, or a base material soaked with tobacco components. However, in Japan, nicotine itself is designated
15 as a pharmaceutical product, and the handling of nicotine is regulated. For example, the sale of nicotine is prohibited, in principle. In such cases, e-cigarettes of a type in which a solution that contains nicotine dissolved in an organic solvent is heated and the resulting aerosol or vapor is inhaled, cannot be sold. Further, nicotine is also designated as a pharmaceutical product in many countries besides Japan. Note that IQOS (trade name), available from Philip Morris International Inc., is a Reduced Risk Product (heated tobacco product (HTP)) of a type in which a dedicated aerosol-generating article (Heatstick (trade name)) is used, and an aerosol containing nicotine that disperses upon the heating of tobacco leaves is inhaled.

25 **[0003]** Patent Document 1 describes, as an example of an aerosol-generating article for use in a heated tobacco product, one having a structure in which a mouthpiece, an aerosol-cooling element, a support element, and an aerosol-forming base material are arranged in this order from a side close to a mouth-end, and also indicates that the aerosol-generating article includes a cellulose acetate tow filter as the mouthpiece, a polylactic acid sheet as the aerosol-cooling element, a hollow cellulose acetate tube as the support element, and tobacco as the aerosol-forming base material.

30 **[0004]** With heated tobacco products, a portion of the aerosol-generating article remains after smoking is finished. Thus, an environmental issue can arise when the remaining used aerosol-generating article is discarded. To address this environmental issue, as described above, a film that uses a biodegradable polylactic acid as a material is used as an aerosol-cooling element of the aerosol-generating article used in a heated tobacco product. Note that in typical cigarette members (cigarettes), a cooling member is not required because the air-flow resistance of the cigarette leaf or filter portion is high.

Citation List

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Patent Document

[0005] Patent Document 1: JP 2015-503335 A

40 Summary of Invention

Technical Problem

45 **[0006]** However, polylactic acid has a low degree of crystallization, and the glass transition temperature (T_g) is also low, and thus the heat resistance of polylactic acid is poor. In particular, polylactic acid has a property of softening and deforming at around 60°C. Thus, aerosol-generating articles that use polylactic acid in a cooling member have poor thermal stability. Therefore, in a heated tobacco product (HTP) in which a polylactic acid film is used as a cooling member, the film is deformed by heat while the product is smoked, and this deformation blocks the air flow channel, and makes smoking difficult.

50 **[0007]** In addition, an aerosol with a temperature of approximately 70°C has to be cooled to room temperature with a cooling member, but the polylactic acid film in the current product has insufficient endothermic performance (cooling performance), and there is a demand for further cooling effects.

[0008] Furthermore, polylactic acid is biodegradable in certain environments, such as at elevated temperatures of around 60°C during composting, but similar to typical general purpose petroleum-based plastics (for example: polypropylene (PP)), polylactic acid does not degrade for the most part in other ordinary environments (for example, in seawater or rivers). As such, polylactic acid films are also inferior in biodegradability.

[0009] Thus, an object of the present invention is to provide an aerosol cooling member excelling in thermal stability, endothermic properties, and biodegradability.

Solution to Problem

[0010] The present disclosure relates to an aerosol cooling member containing cellulose acetate having a total degree of acetyl substitution of greater than 1.4 and not greater than 2.7 as defined in claim 1. Preferred embodiments are given in claims 2 to 14 as well as in the following description.

[0011] The aerosol cooling member preferably has a glass transition temperature of 70°C or higher.

[0012] Preferably, a marine biodegradability performance of the aerosol cooling member is 50% or greater for 180 days as measured in accordance with ASTM D6691.

[0013] With respect to the aerosol cooling member, the cellulose acetate preferably has: τ of not less than 2.0, τ being a ratio of a sum of a degree of acetyl substitution at a 2-position and a degree of acetyl substitution at a 3-position to a degree of acetyl substitution at a 6-position in terms of the total degree of acetyl substitution; and a sulfuric acid component amount of greater than 20 ppm and not greater than 400 ppm.

[0014] With respect to the aerosol cooling member, the amount of sulfuric acid component in the cellulose acetate is preferably from 80 ppm to 380 ppm.

[0015] With respect to the aerosol cooling member, the amount of the sulfuric acid component in the cellulose acetate is preferably from 150 ppm to 350 ppm.

[0016] With respect to the aerosol cooling member, the cellulose acetate preferably has τ of not greater than 2.5, τ being a ratio of a sum of a degree of acetyl substitution at a 2-position and a degree of acetyl substitution at a 3-position to a degree of acetyl substitution at a 6-position in terms of the total degree of acetyl substitution.

[0017] The aerosol cooling member may further include an additive, wherein the additive is one or more selected from the group consisting of a material for which a pH of a 1 wt.% aqueous solution thereof at 20°C is 8 or higher, a material that dissolves at an amount of not less than 2 wt.% in water at 20°C, and a material having excellent biodegradability in the ocean.

[0018] With respect to the aerosol cooling member, a content of the additive is preferably from 4 to 40 wt.%.

[0019] With respect to the aerosol cooling member, the material for which a pH of a 1 wt.% aqueous solution thereof at 20°C is 8 or higher is preferably magnesium oxide.

[0020] With respect to the aerosol cooling member, the material that dissolves at an amount of not less than 2 wt.% in water at 20°C is preferably triacetin.

[0021] The aerosol cooling member may be fibrous.

[0022] The aerosol cooling member may be in a fibrous tow form having a denier per filament of from 0.6 tex to 3.5 tex and a total denier from 1000 tex to 4500 tex.

[0023] The aerosol cooling member may be a particle.

[0024] The aerosol cooling member may be a porous structure.

[0025] The aerosol cooling member may be tubular.

[0026] The aerosol cooling member may be a film.

[0027] The aerosol cooling member preferably has an average temperature decrease rate of water vapor of 5% or greater as measured under Conditions below:

Conditions:

[0028] A film-shaped aerosol cooling member having a length of 23.3 cm, a width of 17 mm, and a thickness of 50 μm is inserted into a tube made of polytetrafluoroethylene and having an inner diameter of 7 mm and a length of 17 mm, water vapor having a temperature of approximately 70°C immediately before passing through the tube is continuously passed through the inside of the tube at a constant flow rate 35 ml/min, and the temperature (°C) of the water vapor immediately before passing through the tube and the temperature (°C) of the water vapor immediately after passing through the tube are measured every 1 second for 120 seconds. An average value of the temperature decrease rate (%) of the water vapor for 120 seconds, as calculated by formulas below, is taken as the average temperature decrease rate of the water vapor:

$$\begin{aligned} \text{Temperature Decrease Rate (\%)} \text{ of Water Vapor} = & [(\text{Temperature (°C) of water} \\ & \text{vapor immediately before passing through the tube}) - (\text{Temperature (°C) of water} \\ & \text{vapor immediately after passing through the tube})] / (\text{Temperature (°C) of water vapor} \\ & \text{immediately before passing through the tube}) \times 100 \end{aligned}$$

Advantageous Effects of Invention

[0029] According to the present invention, an aerosol cooling member excelling in thermal stability, endothermic properties, and biodegradability can be provided.

Description of Embodiments

[Aerosol cooling member]

[0030] An aerosol cooling member according to an embodiment of the present disclosure contains cellulose acetate having a total degree of acetyl substitution of greater than 1.4 and not greater than 2.7.

[0031] In the present disclosure, "aerosol" refers to a colloidal dispersion system in which a solid or liquid is dispersed in a gas, and includes smoke (a state in which a group of microparticles (less than approximately 10 μm) is suspended in a gas).

[0032] The total degree of acetyl substitution of the cellulose acetate contained in the aerosol cooling member according to an embodiment of the present disclosure is greater than 1.4 and not greater than 2.7, preferably not greater than 2.6, more preferably not greater than 2.5, and even more preferably not greater than 2.2. Such a total degree of acetyl substitution is preferable because at such level, the equilibrium moisture ratio is high and endothermic performance (cooling performance) is excellent. The total degree of acetyl substitution may be not less than 1.6, and is preferably not less than 1.8. When the total degree of acetyl substitution of the cellulose acetate is too high, the biodegradability of the aerosol cooling member in seawater is inferior, and when the total degree of acetyl substitution is too low, the moldability of the aerosol cooling member is poor.

[0033] The total degree of acetyl substitution is a sum of each degree of acetyl substitution at the 2-, 3-, and 6-positions of the glucose ring of the cellulose acetate as measured below.

[0034] Each degree of acetyl substitution at the 2-, 3-, and 6-positions of the glucose ring of the cellulose acetate can be measured by NMR in accordance with the Tezuka method (Tezuka, Carbohydr. Res. 273, 83 (1995)). That is, the free hydroxyl group of a cellulose acetate sample is propionylated with propionic anhydride in pyridine. The resulting sample is dissolved in deuterated chloroform, and the ^{13}C -NMR spectrum is measured. The carbon signals of the acetyl group appear in the region from 169 ppm to 171 ppm in the order of position 2-, 3-, and 6- from the high magnetic field; and the carbonyl carbon signals of the propionyl group appear in the region from 172 ppm to 174 ppm in the same order. Each degree of acetyl substitution at the 2-, 3-, and 6-positions of the glucose ring in the original cellulose acetate can be determined from the presence ratio of the acetyl group and the propionyl group at respective positions (in other words, the area ratio of each signal). The degree of acetyl substitution can also be analyzed by ^1H -NMR in addition to ^{13}C -NMR.

[0035] The ratio τ , which is the sum of the degree of acetyl substitution at the 2-position and the degree of acetyl substitution at the 3-position to the degree of acetyl substitution at the 6-position in the total degree of acetyl substitution, is preferably 2.0 or greater. Also, τ may be 2.1 or greater, 2.2 or greater, or 2.3 or greater. The upper limit is not particularly limited, but τ may be not greater than 2.5. The aerosol cooling member exhibits more excellent biodegradability in seawater when τ of the cellulose acetate is 2.0 or greater.

[0036] An amount of a sulfuric acid component in the cellulose acetate of the aerosol cooling member according to an embodiment of the present disclosure preferably exceeds 20 ppm and is not greater than 400, is more preferably from 50 ppm to 380 ppm, is even more preferably from 80 ppm to 380 ppm, is particularly preferably from 100 ppm to 350 ppm, and is most preferably from 150 ppm to 350 ppm. When the amount of the sulfuric acid component is within the above range, the aerosol cooling member exhibits more excellent biodegradability in seawater. As the amount of the sulfuric acid component increases, the biodegradability in seawater increases. In addition, production of the cellulose acetate becomes difficult when the amount of the sulfuric acid component is too high.

[0037] The amount of the sulfuric acid component is the amount calculated in terms of the SO_4^{2-} of a sulfurous acid gas sublimated from dried cellulose acetate.

[0038] The glass transition temperature of the aerosol cooling member according to an embodiment of the present disclosure is preferably 70°C or higher, more preferably 90°C or higher, and even more preferably 110°C or higher. Furthermore, the glass transition temperature may be 190°C or lower, 170°C or lower, or 150°C or lower.

[0039] The glass transition temperature can be measured using a differential scanning calorimeter (DSC).

[0040] In the aerosol cooling member according to an embodiment of the present disclosure, the marine biodegradability performance is, for 180 days, preferably 50% or greater, more preferably 60% or greater, even more preferably 70% or greater, particularly preferably 80% or greater, and most preferably 90% or greater, as measured in accordance with ASTM D6691. As the value indicated by "%" increases, the biodegradability in a marine environment becomes more superior.

[0041] The equilibrium moisture ratio of the aerosol cooling member according to an embodiment of the present disclosure is preferably 1 wt.% or higher, more preferably 2 wt.% or higher, and even more preferably at 4 wt.% or higher.

Additionally, the equilibrium moisture ratio may be 10 wt.% or less. A larger value of the equilibrium moisture ratio indicates more superior endothermic performance (cooling performance).

[0042] The equilibrium moisture ratio in the present disclosure is a value that is obtained by leaving the aerosol cooling member standing at a temperature of 23°C and a relative humidity of 60 RH% for 6 hours or longer to thereby humidify the aerosol cooling member, and subsequently vacuum drying the aerosol cooling member for three full days at a temperature of 40°C, determining the weights immediately after humidification and immediately after drying, and using the weights thereof to calculate the equilibrium moisture ratio using the following formula. Equilibrium Moisture Ratio (wt.%) = (Weight immediately after humidification - weight immediately after drying)/(weight immediately after drying) × 100

[0043] The aerosol cooling member according to an embodiment of the present disclosure may contain an optional component in addition to the cellulose acetate. Examples of the optional component include additives and materials that are highly safe in a marine environment.

[0044] Examples of the additive include one or more additives selected from the group consisting of a material for which a pH of a 1 wt.% aqueous solution thereof at 20°C is 8 or higher, a material that dissolves at an amount of not less than 2 wt.% in water at 20°C, and a material with excellent biodegradability in the ocean.

(Material for which the pH of a 1 wt.% aqueous solution thereof at 20°C is 8 or higher)

[0045] The material for which the pH of a 1 wt.% aqueous solution thereof at 20°C is 8 or higher can be also referred to as a basic additive. The pH of the 1 wt.% aqueous solution of the basic additive at 20°C is preferably 8.5 or higher, and more preferably from 8.5 to 11.

[0046] The pH of the 1 wt.% aqueous solution at 20°C is measured according to a standard procedure, and for example, can be measured with a glass pH electrode.

[0047] In the present disclosure, the "1 wt.% aqueous solution at 20°C" does not require that all the solute be dissolved in water. An aqueous solution typically refers to a liquid in which a solute is dissolved in water (H₂O), that is, a solution in which the solvent is water. The water molecule is a polar molecule, and thus the material that becomes the solute in the aqueous solution is believed to be an ionic crystal or a polar molecular material. However, in the present disclosure, the term "aqueous solution" includes a suspension. That is, the aqueous solution includes a slurry and a colloidal solution, which are disperse systems in which solid particles are dispersed in a liquid. In addition, the "1 wt.% aqueous solution at 20°C" in the present disclosure includes those aqueous solutions for which, when 1 wt.% of the basic additive is added to water, a portion of the basic additive dissolves and forms an aqueous solution, and a remaining portion of the basic additive forms a suspension.

[0048] The solid particles may be colloidal particles (for example, approximately 100 nm or less), or may be particles larger than colloidal particles. A suspension of colloidal particles is referred to as a colloidal solution, and a suspension of particles larger than colloidal particles may be referred to simply as suspension. Unlike a colloidal solution, a suspension of particles larger than the colloidal particles settles to a steady state over time. The solid particles larger than colloidal particles can be seen under a microscope and may subside over time when placed in a quiet location.

[0049] When the basic additive in the aqueous solution is an inorganic material that is ionized in the aqueous solution, the surface of the inorganic material adsorbs and charges ions by the effect of the surface charge of the particles and affects the ion distribution in the vicinity of the surface. This effect causes a distribution of ions around the surface of the basic additive called an electric double layer, the distribution different from that in the solution (solvent) outside the vicinity of the particle interface. The electric double layer is formed of a fixed layer in which ions are strongly adsorbed on the particle surface and a diffusion layer that exists away from the fixed layer. Also when the basic additive of the present disclosure is not dissolved in water, the pH of the dispersion medium changes because of the surface charge of the basic additive as described above.

[0050] Examples of the material (basic additive) for which the pH of a 1 wt.% aqueous solution thereof at 20°C is 8 or higher include oxides, hydroxides, carbonates, acetates, ammonium salts, aluminates, silicates, or metasilicates of alkaline earth metals or alkali metals; ZnO; and basic Al₂O₃.

[0051] The basic additive is preferably one or more selected from the group consisting of oxides, hydroxides, carbonates, ammonium salts, aluminates, silicates, or metasilicates of alkaline earth metals or alkali metals; ZnO; and basic Al₂O₃.

[0052] The basic additive is more preferably one or more selected from the group consisting of oxides, hydroxides, aluminates, silicates, or metasilicates of alkaline earth metals or alkali metals; ZnO; and basic Al₂O₃.

[0053] The basic additive is even more preferably one or more selected from the group consisting of oxides, aluminates, silicates, or metasilicates of alkaline earth metals or alkali metals; ZnO; and basic Al₂O₃.

[0054] The basic additive is still even more preferably one or more selected from the group consisting of oxides, aluminates, silicates, and metasilicates of alkaline earth metals or alkali metals.

[0055] The basic additive is particularly preferably an oxide of an alkaline earth metal. Magnesium oxide (MgO) is one

of the most preferred basic additives.

[0056] An example of the metasilicates of alkaline earth metals or alkali metals is magnesium aluminometasilicate, which is represented by the general formula $\text{Al}_2\text{O}_3 \cdot \text{MgO} \cdot 2\text{SiO}_2 \cdot x\text{H}_2\text{O}$ (where x represents the number of waters of crystallization, and $1 \leq x \leq 10$). Magnesium aluminometasilicate itself is well known, and a commercially available product

can also be used. For example, magnesium aluminometasilicate of the Japanese Pharmaceutical Codex can be suitably used. Magnesium metasilicate aluminate is marketed under the trade designation of Neusilin (trade name) as an antacid.

[0057] The basic additive according to an embodiment of the present disclosure need not necessarily be water soluble, and may have a solubility from 10^{-7} to 70 g per 100 mL of water at 20°C. The basic additive according to an embodiment of the present disclosure preferably has a solubility of not less than 10^{-6} g per 100 mL of water at 20°C, more preferably has a solubility of not less than 10^{-5} g per 100 mL of water at 20°C, and even more preferably has a solubility of not less than 10^{-4} g per 100 mL of water at 20°C. In addition, the basic additive preferably has a solubility of not greater than 10 g per 100 mL of water at 20°C, more preferably has a solubility of not greater than 1 g per 100 mL of water at 20°C, and even more preferably has a solubility of not greater than 0.1 g per 100 mL of water at 20°C.

[0058] Examples of the additive having a solubility in water of about 10^{-4} g/100 mL (20°C) include MgO, ZnO, and $\text{Mg}(\text{OH})_2$. An example of the additive having a solubility in water of about 10^{-2} g/100 mL (20°C) is MgCO_3 . Examples of the additive having a solubility in water of about 0.1 g/100 mL (20°C) include CaO and $\text{Ca}(\text{OH})_2$.

(Material dissolving at not less than 2 wt.% in water at 20°C)

[0059] The material dissolving at not less than 2 wt.% in water at 20°C may be either a high molecular weight material or a low molecular weight material as long as the material is water soluble.

[0060] Examples of the high molecular weight material include hydrophilic polymers, and examples of the high molecular weight material include polysaccharides and plasticizers for cellulose acetate. Examples of the polysaccharides include oligosaccharides (powdered oligosaccharides), reduced starch syrup, and cluster dextrin. Examples of oligosaccharides include starch sugars (starch saccharification products), galactooligosaccharides, coupling sugars, fructooligosaccharides, xylooligosaccharides, soybean oligosaccharides, chitin oligosaccharides, and chitosan oligosaccharides, and these components can be used alone or in a combination of two or more.

[0061] The material dissolving at not less than 2 wt.% in water at 20°C described above preferably contains a plasticizer for cellulose acetate.

(Plasticizer for cellulose acetate)

[0062] Details of plasticizers are exemplified in the "Handbook of Plasticizers", Ed., Wypych, George, ChemTec Publishing (2004). Plasticizers can be used alone or as a mixture of two or more.

[0063] In addition, as the plasticizer, a glycerin ester plasticizer can be used. As the glycerin ester plasticizer, a lower fatty acid ester of glycerin, in other words, an ester compound of glycerin and a fatty acid having from 2 to 4 carbons can be used. A fatty acid having 2 carbons is acetic acid, a fatty acid having 3 carbons is propionic acid, and a fatty acid having 4 carbons is butyl acid. The glycerin ester plasticizer may be an ester in which all three hydroxyl groups of glycerin are esterified with the same fatty acids, an ester in which two hydroxyl groups are esterified with the same fatty acids, or an ester in which all three hydroxyl groups of glycerin are esterified with different fatty acids.

[0064] Glycerin ester plasticizers are non-toxic and easily biodegraded, and thus have a small environmental load. In addition, the addition of a glycerin ester plasticizer to the cellulose acetate can lower the glass transition temperature of the resulting aerosol cooling member. Thus, this can also impart excellent thermoformability to the raw material.

[0065] When the fatty acid is acetic acid, examples of the glycerin ester plasticizer include triacetin, in which three hydroxyl groups of glycerin are esterified with acetic acid, and diacetin, in which two hydroxyl groups are esterified with acetic acid.

[0066] Among the glycerin ester plasticizers described above, triacetin (glycerol triacetate), in which all three hydroxyl groups of glycerin are esterified with acetic acid (in other words, acetylated), is preferred. Triacetin is a component recognized as safe for humans even when ingested. Triacetin is also easily biodegraded, and thus has a small environmental load. In addition, the biodegradability of an aerosol cooling member obtained by adding triacetin to the cellulose acetate is improved compared to a case in which cellulose acetate is used alone. Furthermore, the addition of triacetin to the cellulose acetate can efficiently lower the glass transition temperature. Thus, this can impart excellent thermoformability to the raw material.

[0067] Triacetin is preferably pure in terms of chemical structure and high in purity. In addition, for example, a plasticizer containing not less than 80 wt.% or not less than 90 wt.% of triacetin with the remaining being monoacetin and/or diacetin may be used.

(Material with excellent biodegradability in the ocean)

[0068] The addition of a material with excellent biodegradability in the ocean can promote biodegradability of the aerosol cooling member. Examples of the material with excellent biodegradability in the ocean include compounds with excellent biodegradability in the ocean. Examples of such compounds include polyhydroxyalkanoates such as poly[hydroxybutyrate-co-hydroxyhexanoate] (PHBH), polyhydroxybutyrate, and thermoplastic starch resins (including acetylated starch).

[0069] The process of biodegradation of the cellulose acetate contained in the aerosol cooling member according to an embodiment of the present disclosure is as follows. The mechanism of biodegradation of cellulose acetate is commonly believed to be a mechanism in which once each acetyl group of the cellulose acetate is hydrolyzed, the resulting cellulose acetate with a reduced degree of substitution undergoes degradation by an action of a cellulose-degrading enzyme (e.g., β -glucosidase; EC 3.2.1.21). β -glucosidase (EC 3.2.1.21) is an enzyme that catalyzes the hydrolysis of β -glycosidic linkages in sugars and is also called β -D-glucoside glucohydrolase and amygdalase. The β -glycosidic linkage constituting the polymer chain of cellulose acetate is hydrolyzed, and the resulting monosaccharides and low molecular weight polysaccharides then undergo degradation through metabolism by common microorganisms. Thus, to promote biodegradability, promoting the detachment of acetyl groups is effective.

[0070] The ocean is weakly basic, and this basicity also leads to deacetylation of cellulose acetate. As a result of examinations, it was found that deacetylation (hydrolysis) under basic conditions is faster at the 2- and 3-positions in the glucose ring than at the 6-position. Thus, for example, for cellulose acetates with the same total degree of substitution, it was found that a cellulose acetate with higher degree of substitution at the 2- and 3-positions than at the 6-position results in a faster rate of decrease in the total degree of substitution and leads to faster biodegradation. In addition, it was found that when the amount of the sulfuric acid component in the cellulose acetate at that time is from greater than 20 ppm to 400 ppm or less, more excellent biodegradability is achieved. When the amount of the sulfuric acid component is in excess, there is a concern that degradation may occur when used as a product that is immersed in the ocean. These effects are considered to exhibit the same tendency in any total degree of substitution, when compared among the cellulose acetates having the same total degree of substitution. However, the cellulose acetate with a total degree of acetyl substitution of not greater than 2.7 has an excellent level of biodegradability.

[0071] When a material for which the pH of a 1 wt.% aqueous solution thereof at 20°C is 8 or higher is contained, the degradation mechanism of the aerosol cooling member according to an embodiment of the present disclosure is as follows. Although this mechanism is a speculation, it is thought that a material (basic additive) for which the pH of a 1 wt.% aqueous solution thereof at 20°C is 8 or higher promotes hydrolysis (deacetylation) of the cellulose acetate in weakly basic seawater. This deacetylation effect due to the basic material is remarkable in a cellulose acetate having more acetyl groups at the 2- and 3-positions than at the 6-position, and is more remarkable in a cellulose acetate having a large amount of sulfuric acid components. It is thought that as a result, the degree of substitution of the cellulose acetate constituting the aerosol cooling member is reduced, and this can then contribute to improved biodegradability. These properties are preferably exhibited immediately upon contact with seawater, without being exhibited during use of the aerosol cooling member as a product. Thus, the basic material is dispersed as solid particles in the aerosol cooling member, the particle diameter of the basic material is preferably as fine as possible, and the specific surface area is preferably large.

[0072] In addition, the aerosol cooling member according to an embodiment of the present disclosure can contain a material that dissolves at an amount of not less than 2 wt.% in water at 20°C. Such a material can dissolve in seawater when the aerosol cooling member is immersed in seawater. In addition, such a material escapes from the aerosol cooling member and thereby forms structural gaps in a molded article configured by the aerosol cooling member. This allows microorganisms to easily enter the gaps and increases the surface area of the molded article configured by a composition of cellulose acetate. As a result, such a material can contribute to improved biodegradability. Examples of the material include triacetin and diacetin. Triacetin and diacetin also act as plasticizers for the cellulose acetate and thus can contribute to improving thermoformability.

[0073] The content of the additive in the aerosol cooling member, in terms of the total content, is preferably not greater than 40 wt.%, more preferably not greater than 30 wt.%, and even more preferably not greater than 20 wt.%. In addition, the content of the additive is preferably not less than 4 wt.%, more preferably not less than 5 wt.%, and even more preferably not less than 10 wt.%.

[0074] The content of the basic additive (material for which the pH of a 1 wt.% aqueous solution thereof at 20°C is 8 or higher) in the aerosol cooling member is preferably from 1 to 30 wt.%, more preferably from 2 to 20 wt.%, even more preferably from 3 to 15 wt.%, and particularly preferably from 4 to 10 wt.%. An excess amount of the basic additive could cause problems in areas such as moldability including difficulty in molding the aerosol cooling member.

[0075] The content of the water-soluble additive (material dissolving at not less than 2 wt.% in water at 20°C) in the aerosol cooling member is preferably from 5 to 30 wt.%, more preferably from 7.5 to 28 wt.%, and even more preferably from 10 to 25 wt.%. An excess amount of the water-soluble additive reduces the strength of the aerosol cooling member.

[0076] The content of the material excelling in biodegradability in the ocean with respect to the aerosol cooling member is preferably from 5 to 40 wt.%.
[0077] The aerosol cooling member according to an embodiment of the present disclosure can be used in a mixture with another material to improve biodegradability of the mixture as a whole.

[0078] Although the basic material is added to the aerosol cooling member, the effect from the addition of the basic material may not be obtained in a case in which the composition contains, for example, an acidic material, undergoes a neutralization reaction when immersed in water, and becomes neutral to acidic.

[0079] Thus, when the aerosol cooling member according to an embodiment of the present disclosure is mixed with water to obtain a slurry, the pH of the slurry at 20°C is preferably from 7 to 13, and is more preferably from 8 to 12.

[0080] The biodegradation of the cellulose acetate of the present disclosure is thought to occur as follows. Namely, acetyl groups are first detached, the degree of acetyl substitution is reduced and approaches that of cellulose, and the cellulose acetate is degraded by the action of microorganisms. Thus, the additive is preferably an additive promoting the degradation of the cellulose acetate.

[0081] The shape of the aerosol cooling member according to an embodiment of the present disclosure is not particularly limited, and for example, may be fibrous, film-shaped, particle-shaped, a porous structure, or tubular. The fibers may also form the shape of a fiber tow.

[0082] Fibrous means a shape with a fiber diameter of not greater than 0.2 mm and an aspect ratio of greater than 50.

[0083] Examples of the fiber tow shaped aerosol cooling member include a fiber tow shape having a denier per filament from 0.6 tex to 3.5 tex and a total denier from 1000 tex to 4500 tex. When the denier per filament and total denier are within the above ranges, the balance between the cooling effect and the air permeability of the aerosol is favorable, and thus such ranges are preferable. If the denier per filament is too small, the air-flow resistance may be too high, and the smoke flavor components in the aerosol may be excessively adsorbed.

[0084] "Particle-shaped" refers to a shape in which the particle diameter is 5 mm or less and the aspect ratio is from 0.1 to 50.

[0085] When the aerosol cooling member is particle-shaped, the upper limit of the particle diameter may be, for example, 3.35 mm, 3.0 mm, 2.5 mm, 2.0 mm, or 1.5 mm. The lower limit of the particle diameter may be, for example, 0.18 mm, 0.20 mm, 0.30 mm, 0.40 mm, or 0.50 mm.

[0086] Furthermore, the particle diameter is defined as the minimum value of the mesh size of a sieve through which the aerosol cooling member can pass, from among test sieves conforming to JIS Z 8801.

[0087] When the aerosol cooling member is in the form of particles, a proportion of particles having a particle diameter of not greater than 2 mm is preferably 50 wt.% or less. This is due to excellent biodegradability of such particles.

[0088] The proportion (wt.%) of particles having a particle diameter of not greater than 2 mm can be determined using a sieve specified in JIS Z 8801. That is, the proportion thereof can be determined by attaching a receiving pan and a sieve having mesh openings of 2 mm to a RO-TAP sieve shaker (available from Sieve Factory Iida Co., Ltd., tapping: 156 times/min, rolling: 290 times/min), oscillating 100 g of a sample for 5 minutes, and then calculating the proportion of the weight of the particles in the receiving pan relative to the total weight (100 g of the sample).

[0089] When the aerosol cooling member is in the form of particles, each particle may have one or a plurality of faces, and each face may be in a shape selected from any of circular, triangular, quadrilateral, pentagonal, and hexagonal shapes. In addition, each side length may be set to a value in a range from 0.18 mm to 3.35 mm, or in a range from 0.18 mm to less than 3.00 mm. Note that a particle shape having a plurality of faces is referred to as a polyhedral shape.

[0090] When the aerosol cooling member is in the form of particles, each particle may be formed in a cylindrical (including ellipsoid) shape. In addition, each side length may be set to a value in a range from 0.18 mm to 3.35 mm, or in a range from 0.18 mm to less than 3.00 mm.

[0091] The side length refers to a linear distance between adjacent vertices at the projected plane when viewed from a certain angle, or the intersecting line distance between faces. In addition, the polyhedrons, cylinders, and elliptical cylinders mentioned here also include shapes having some shape error that may occur during production, for example.

[0092] "Porous structure" refers to a porous structure having a continuous porosity of not less than 50%.

[0093] "Tubular" refers to a structure that forms a hollow tube shape. The tubular shape may be a hollow shape having substantially the same cross-section along the axial direction of the member, or may have a circular, elliptical, rectangular, or polygonal cross-sectional shape. Tubular refers to an elongated shape for which the shape is maintained at the outer side, a hollow cavity is present in the inside, and at least a portion of the cavity is opened to the outside. Note that it is not necessary for both ends to be penetrated, and the tubular form is not required to be penetrating in all cross sections.

[0094] "Film-shaped" refers to a shape in the form of a thin film with a thickness of 200 μm or less.

[0095] When the aerosol cooling member is formed in the shape of a film, the air-flow resistance (air-flow resistance per unit weight) measured under the following conditions may be 1 mmWG/g or greater, 5 mmWG/g or greater, 10 mmWG/g or greater, 30 mmWG/g or greater, or 40 mmWG/g or greater. The air-flow resistance may also be 1500 mmWG/g or less, 1000 mmWG/g or less, 500 mmWG/g or less, 100 mmWG/g or less, or 50 mmWG/g or less.

[0096] A film-shaped aerosol cooling member having a length of 23.3 cm, a width of 17 mm, and a thickness of 50

μm is inserted into a polytetrafluoroethylene tube having an inner diameter of 7 mm and a length of 17 mm. The tube containing the aerosol cooling member is then inserted into a sample holder of an air-flow resistance measuring instrument (available from OTIC KATO KOGYOSHO TOKYO), and the air-flow resistance (mmWG) may be measured.

[0097] When the aerosol cooling member has a film shape, the average temperature decrease rate of the water vapor measured under the following conditions is preferably 5% or higher, more preferably 8% or higher, and even more preferably 10% or higher.

[0098] A film-shaped aerosol cooling member having a length of 23.3 cm, a width of 17 mm, and a thickness of 50 μm is inserted into a tube made of polytetrafluoroethylene and having an inner diameter of 7 mm and a length of 17 mm, water vapor having a temperature of approximately 70°C immediately before passing through the tube is continuously passed through the inside of the tube at a constant flow rate 35 ml/min, and the temperature (°C) of the water vapor immediately before passing through the tube and the temperature (°C) of the water vapor immediately after passing through the tube are measured every 1 second for 120 seconds. An average value of the temperature decrease rate (%) of the water vapor over the period of 120 seconds, calculated by the following formula, is taken as the average temperature decrease rate of the water vapor.

[0099] Temperature Decrease Rate (%) of Water Vapor = [(Temperature (°C) of water vapor immediately before passing through tube) - (Temperature (°C) of water vapor immediately after passing through tube)] / (Temperature (°C) of water vapor immediately before passing through tube) $\times$ 100

[0100] When the aerosol cooling member is in the shape of a film, the thickness of the film is preferably not greater than 100 μm , more preferably not greater than 80 μm , and even more preferably not greater than 60 μm . This is because the thickness does not have a significant impact on the cooling effect, but has a negative effect of increasing the air-flow resistance.

[Aerosol cooling member production method]

[0101] The method for producing the aerosol cooling member according to an embodiment of the present disclosure is not particularly limited, and examples include the following methods. A method that includes mixing cellulose acetate with a solvent such as acetone, and removing the solvent (when the aerosol cooling member is molded into a fibrous form, specific examples of the method thereof include a method of molding cellulose acetate dissolved in a solvent, as exemplified by dry spinning), and a melt molding method (for example, extrusion molding) in which cellulose acetate is heated and melted with an additive. Either method may further include thermoforming into a desired shape.

[0102] Methods that can be used to include an additive include, for example, a method of mixing the cellulose acetate and the additive in advance prior to mixing with the solvent or prior to melt molding, and forming a mixture of cellulose and the additive, a method of mixing an additive into a solution obtained by mixing cellulose acetate with a solvent, and a method of mixing cellulose acetate and an additive in parallel with mixing with a solvent or melt molding.

(Method for producing cellulose acetate)

[0103] The method for producing the cellulose acetate used as a raw material of the aerosol cooling member is not particularly limited, and examples include the following method. A production method including (a) producing a cellulose acetate dope by allowing a cellulose and acetic anhydride to react in the presence of an acid catalyst and an acetic acid solvent, (b) hydrolyzing the produced cellulose acetate to achieve a total degree of acetyl substitution of greater than 1.4 and not greater than 2.7, and (c) precipitating the hydrolyzed cellulose acetate with a precipitant.

[0104] A case in which a molding step is included to mold the aerosol cooling member according to an embodiment of the present disclosure into a desired shape is described.

[0105] In the case of molding into a fibrous form, the molding method is not particularly limited, and examples thereof include methods such as a known dry spinning method using a spinning solution containing a spinning solution and a cellulose acetate according to an embodiment of the present disclosure. Examples of the spinning solution include acetone.

[0106] In addition, in a case in which the aerosol cooling member is molded into a fiber tow shape, the molding method is not particularly limited, and examples thereof include known methods in which monofilaments of a quantity of around from 100 to 1000000, from 500 to 50000, or from 1000 to 10000 are bundled (converged).

[0107] In a case in which the aerosol cooling member is molded into the form of particles, the molding method is not particularly limited, and an example includes a method of, first, preparing the cellulose acetate (and additives such as a plasticizer as necessary) through dry or wet pre-mixing using a mixer such as a tumbler mixer, a Henschel mixer, a ribbon mixer, or a kneader, then melt-kneading the material in an extruder such as a single or twin screw extruder, extruding the melt-kneaded product into the form of strands, and cutting the strands to prepare the aerosol cooling member in the form of pellets.

[0108] The specific method for forming a porous structure with a foamed body, or a three-dimensional molded article

such as one with a tubular or hollow cylindrical form from a pellet-shaped aerosol molded article through melt extrusion molding is not particularly limited, and for example, injection molding, extrusion molding, vacuum molding, profile molding, foam molding, injection pressing, press molding, blow molding, gas injection molding can be used.

[0109] In the case of molding into a film shape, examples of the molding method include known melt film formation methods using cellulose acetate according to an embodiment of the present disclosure, and known solvent casting film formation methods using a solution of cellulose acetate according to an embodiment of the present disclosure.

Examples

[0110] Hereinafter, the present invention will be specifically described with reference to examples, but the technical scope of the present invention is not limited by these examples.

[0111] Each physical property of the Examples and Comparative Examples described below were evaluated by the following methods.

<Degrees of acetyl substitution at 2-, 3-, and 6-positions and total degree of acetyl substitution>

[0112] The degrees of acetyl substitution at the 2-, 3-, and 6-positions of the glucose ring of the cellulose acetate were each measured according to the method of Tezuka (Tezuka, Carbohydr. Res. 273, 83 (1995)) as described above by propionylating the free hydroxyl group of a cellulose acetate sample using propionic anhydride in pyridine, dissolving the resulting sample in deuterated chloroform, and measuring the ^{13}C -NMR spectrum. Then, the degrees of acetyl substitution at the 2-, 3-, and 6-positions (DS2, DS3, and DS6) were determined from surface area ratios of respective carbon signals of the acetyl groups appearing in the order of the 2-, 3-, and 6-positions from the high magnetic field in the region from 169 ppm to 171 ppm. The total degree of acetyl substitution is the sum of the degrees of acetyl substitution at the 2-, 3-, and 6-positions. In addition, the sum of the degree of acetyl substitution at the 2-position and the degree of acetyl substitution at the 3-position (DS2 + 3) and the ratio τ of the sum of the degree of acetyl substitution at the 2-position and the degree of acetyl substitution at the 3-position to the degree of acetyl substitution at the 6-position were calculated.

<Sulfuric acid component amount>

[0113] Dried cellulose acetate was burned in an electric furnace at 1300°C , sublimated sulfurous acid gas was trapped in a 10% hydrogen peroxide solution and titrated with a normal aqueous solution of sodium hydroxide, and the amount of the sulfuric acid component was measured in terms of SO_4^{2-} . The amount of the sulfuric acid component amount was expressed in units of ppm as the amount of sulfuric acid component in 1 g of the cellulose acetate in an absolute dry state.

<Slurry pH>

[0114] First, 2.0 g of a dried sample in the form of a fine powder was accurately weighed, 80 mL of boiled distilled water was added thereto and stirred. The mixture was then sealed and allowed to stand for one night, after which the mixture was further stirred, and the sample was precipitated. About 10 mL of the supernatant was taken as the sample liquid, and the pH was measured with a calibrated pH meter. The pH of the boiled distilled water was also measured as a blank, and the hydrogen ion concentration $[\text{H}^+]_s$ of the sample liquid and the hydrogen ion concentration $[\text{H}^+]_b$ of the blank liquid (where s represents the sample and b represents the blank) were each calculated by the formula $[\text{H}^+] = 10^{-(\text{pH})}$ (where pH represents the measured pH value).

[0115] When $[\text{H}^+]_s \geq [\text{H}^+]_b$, the slurry pH was calculated by the following formula.

$$\text{Slurry pH} = -\log([\text{H}^+]_s - [\text{H}^+]_b)$$

[0116] When $[\text{H}^+]_s < [\text{H}^+]_b$, the hydroxyl group ion concentrations $[\text{OH}^-]_s$ of the sample liquid and $[\text{OH}^-]_b$ of the blank liquid were each calculated by the formula $[\text{OH}^-] = 10^{-14}/[\text{H}^+]$, and the slurry pH was then calculated by the following formula.

$$\text{Slurry pH} = 14 + \log([\text{OH}^-]_s - [\text{OH}^-]_b + 10^{-7})$$

<Thermal stability 1 (glass transition temperature (T_g))>

[0117] The glass transition temperature (T_g) was measured under the following measurement conditions using a differential scanning calorimeter (DSC-Q2000, available from TA Instruments Inc.).

Measurement Conditions:

[0118] Atmosphere: nitrogen

Temperature range: 30°C to 280°C

Rate of temperature increase: 10°C/min

<Thermal stability 2 (rate of increase in air-flow resistance)>

[0119] A film-shaped sample having a length of 23.3 cm, a width of 17 mm, and a thickness of 50 μm was inserted into a polytetrafluoroethylene tube having an inner diameter of 7 mm and a length of 17 mm. The tube containing the sample was then inserted into a sample holder of an air-flow resistance measuring instrument (available from OTIC KATO KOGYOSHO TOKYO), and the air-flow resistance (mmWG) was measured.

[0120] Subsequently, water vapor at a temperature of approximately 70°C immediately prior to passing through the tube in which the sample was inserted was then continuously passed through the tube at a constant flow rate of 35 ml/min for 120 seconds. The tube containing the sample and through which was passed this water vapor was inserted into the sample holder of the air-flow resistance measuring instrument, and the air-flow resistance (mmWG) was measured once again.

[0121] The percentage (%) of increase in the air-flow resistance after the passage of the water vapor relative to the air-flow resistance prior to the passage of the water vapor was calculated. The measurements were performed five times (n = 5), and the percentage of increase in the air-flow resistance was determined as the average value of the five measurements.

<Endothermic property 1 (equilibrium moisture ratio)>

[0122] A film-shaped sample having a length of 23.3 cm, a width of 17 mm, and a thickness of 50 μm was left standing at a temperature of 23°C and a relative humidity of 60 RH% for 6 hours or longer to thereby humidify the sample, after which the sample was vacuum dried for three full days at a temperature of 40°C, and the weight immediately after humidification and the weight immediately after drying were determined. The equilibrium moisture ratio was calculated using the following formula: Equilibrium Moisture Ratio (wt.%) = (Weight immediately after humidification - weight immediately after drying)/(weight immediately after drying) × 100

<Endothermic property 2 (rate of temperature decrease of water vapor)>

[0123] A film-shaped sample having a length of 23.3 cm, a width of 17 mm, and a thickness of 50 μm was inserted into a tube made of polytetrafluoroethylene and having an inner diameter of 7 mm and a length of 17 mm, water vapor having a temperature of approximately 70°C immediately before passing through the tube was continuously passed through the inside of the tube at a constant flow rate 35 ml/min, and the temperature (°C) of the water vapor immediately before passing through the tube and the temperature (°C) of the water vapor after passing through the tube were measured every 1 second for 120 seconds. The average value of the temperature decrease rate (%) of the water vapor over the period of 120 seconds, calculated by the following formula, was taken as the average temperature decrease rate of the water vapor.

$$\text{Temperature Decrease Rate (\%)} \text{ of Water Vapor} = [(\text{Temperature (°C) of water vapor immediately before passing through the tube}) - (\text{Temperature (°C) of water vapor immediately after passing through the tube})] / (\text{Temperature (°C) of water vapor immediately before passing through the tube}) \times 100$$

[0124] For a case in which water vapor was similarly passed through a tube in which a sample was not inserted, the temperature (°C) of the water vapor immediately prior to passing through the tube and the temperature (°C) of the water

vapor immediately after passing through the tube were determined in advance as blank values. For the case in which water vapor was passed through the tube in which the sample was inserted, the temperature (°C) of the water vapor immediately prior to passing through the tube and the temperature (°C) of the water vapor immediately after passing through the tube were values from which the respective temperatures of the blanks were subtracted.

<Biodegradability (marine biodegradability performance)>

[0125] Biodegradability was evaluated using a method for evaluating biodegradability by immersion in seawater. First, a film was produced by a typical solvent casting method. From 10 to 15 parts by weight of the sample were dissolved in from 85 to 90 parts by weight of acetone, a predetermined amount of MgO was further added, and a dope was prepared. The dope was allowed to flow on a glass plate and casted with a bar coater. The dope was dried at 40°C for 30 minutes, and an obtained film was peeled from the glass plate and further dried at 80°C for 30 minutes, and a film for evaluation with a thickness of 30 μm was obtained.

[0126] The film (10 cm × 10 cm × 30 μm) produced by the method described above was shredded with a liquid nitrogen freeze grinder (S6770 FREEZER/MILL, available from Spex Sampleprep, LLC of Metuchen, New Jersey, USA) and inserted into a stainless steel container, and the biodegradability (marine biodegradability performance) was determined by a method according to ASTM D6691. The biodegradability was specifically determined as follows.

[0127] The amount of carbon dioxide discharged from each sample was measured at 90 days and 180 days after the start of the biodegradability test. As indicated in the formula below, the percentage of the amount of carbon dioxide discharged from each sample relative to the theoretical amount of biochemical discharge of carbon dioxide in complete degradation based on the chemical composition was calculated as the biodegradation degree (%). The biodegradation degree (%) of each sample at 90 days and 180 days after starting the biodegradation test was converted to a relative value with respect to a case in which the biodegradation degree of cellulose was considered to be 100. This converted value was defined as the marine biodegradability performance (%).

$$\text{Biodegradation degree (\%)} = \left[\frac{\{(\text{amount of carbon dioxide discharged from each sample}) - (\text{amount of carbon dioxide as blank})\}}{(\text{amount of theoretical biochemical carbon dioxide discharge in complete degradation based on chemical composition})} \right] \times 100$$

[0128] Amount of carbon dioxide as a blank: The amount of carbon dioxide discharged when the biodegradation test was similarly implemented using a stainless steel container not containing a sample.

Examples 1 to 8

[0129] Cellulose (hardwood pulp) in the form of a sheet was processed with a disc refiner into a cotton-like form. Next, 32.71 parts by weight of acetic acid was sprayed onto 100 parts by weight of the cotton-like cellulose (water content percentage of 8.0 wt.%), and the mixture was well stirred and then left standing at a temperature of 24°C for 60 minutes (activating step). Next, 358.51 parts by weight of acetic acid, 214.99 parts by weight of acetic anhydride, and A parts by weight of sulfuric acid were mixed with the activated cellulose. The mixture was maintained at 15°C for 20 minutes, after which the temperature of the reaction system was increased to 45°C at a rate of temperature increase of 0.3 1°C/min and then maintained at 45°C for 70 minutes, and the cellulose was acetylated, and cellulose triacetate was produced. Then, 0.28 parts by weight of acetic acid, 89.55 parts by weight of water, and 13.60 parts by weight of magnesium acetate were added, and the acetylation reaction was stopped. The sulfuric acid amount A was appropriately adjusted in a range from 0.1 to 15 parts by weight, and the sulfuric acid amount of the cellulose acetate to be synthesized was adjusted. To the resulting reaction mixture, 0.06 parts by weight of acetic acid, B parts by weight of water, and 2.90 parts by weight of magnesium acetate were added, and an aging reaction was performed at 85°C for C minutes. The amount of water B to be added to the aging reaction was adjusted in a range of from 1 to 50 parts by weight, and the degrees of substitutions at the 2-, 3-, and 6-positions were adjusted. The aging reaction time C was adjusted in a range from 5 to 120 minutes, and the degree of substitution of the cellulose acetate to be synthesized was adjusted. Cellulose acetate was thus obtained. The evaluation results of each physical property are shown in Table 1.

Example 9

[0130] An amount of 9.5 parts by weight of the cellulose acetate having a degree of substitution of 2.46 and synthesized in Example 1 was heated at 110°C for 2 hours and dried, after which the cellulose acetate was added to 90 parts by weight of acetone, stirred at 25°C for 6 hours, and dissolved. To this mixed solution, 0.5 parts by weight of a powder of magnesium aluminometasilicate, which is a basic additive, was added as an additive, the mixture was further stirred at 25°C for 6 hours, and a dope was thereby prepared.

[0131] The prepared dope was allowed to flow onto a glass plate and casted with a bar coater, and then dried at 40°C for 30 minutes. Next, the obtained film was peeled off from the glass plate and dried at 80°C for another 30 minutes, and a film having a thickness of 30 μm was obtained. Biodegradability was evaluated by the method described above using this film as an evaluation film. The evaluation results of each physical property are shown in Table 1.

Example 10

[0132] A dope was prepared in the same manner as in Example 9 with the exception that 0.4 parts by weight of magnesium oxide were used as the basic additive, and the amount of the cellulose acetate was changed to 9.6 parts by weight. After the dope was prepared, each of the physical properties was evaluated in the same manner as in Example 9. The results are shown in Table 1.

Example 11

[0133] A dope was prepared in the same manner as in Example 9 with the exception that as an additive, in addition to the basic additive, 2.5 parts by weight of triacetin, which is a water-soluble additive, was used, and the amount of the cellulose acetate was changed to 7.5 parts by weight. After the dope was prepared, each of the physical properties was evaluated in the same manner as in Example 9. The results are shown in Table 1.

Example 12

[0134] A dope was prepared in the same manner as in Example 9 with the exception that as additives, 0.5 parts by weight of magnesium oxide, which is a basic additive, and 2.0 parts by weight of triacetin, which is a water-soluble additive, were used, and the amount of the cellulose acetate was changed to 7.5 parts by weight. After the dope was prepared, each of the physical properties was evaluated in the same manner as in Example 9. The results are shown in Table 1.

Example 13

[0135] A dope was prepared in the same manner as in Example 9 with the exception that as the cellulose acetate, 7.5 parts by weight of the cellulose acetate synthesized in Example 5 with a substitution degree of 2.45 was used, and as an additive, in addition to the basic additive, 2.5 parts by weight of triacetin, which is a water-soluble additive, was used. The dope was allowed to flow onto a glass plate, and was then casted with a bar coater and dried at 40°C for 30 minutes. Next, the obtained film was peeled off from the glass plate, dried at 80°C for another 30 minutes, and a film having length of 23.3 cm, a width of 17 mm, and a thickness of 30 μm was obtained. The physical properties were evaluated by the method described above using this film as an evaluation film. The results are shown in Tables 1 and 2.

Example 14

[0136] A dope was prepared in the same manner as in Example 9 with the exception that as the cellulose acetate, 7.5 parts by weight of the cellulose acetate synthesized in Example 8 with a substitution degree of 2.20 was used, and as an additive, in addition to the basic additive, 2.5 parts by weight of triacetin, which is a water-soluble additive, was used. After the dope was prepared, a film was obtained in the same manner as in Example 13. The physical properties were evaluated by the method described above using this film as an evaluation film. The results are shown in Table 1.

Comparative Example 1

[0137] Polylactic acid was melt kneaded at a temperature from 170 to 190°C using a twin screw kneader, and a film was obtained using a T-die mold of a laboratory plastomil. The evaluation results of each physical property are shown in Table 1 and Table 2.

Comparative Example 2

[0138] Cellulose (cotton linter pulp) in the form of a sheet and having an α -cellulose content of 97 wt.% was processed with a disc refiner into a cotton-like form. Acetic acid at a proportion indicated was sprayed onto 100 parts by weight of the cotton-like cellulose (water content percentage of 8.0 wt.%), and the mixture was stirred well and then left standing at a temperature of 24°C for 60 minutes (first activating step). Furthermore, 30.24 parts of acetic acid containing 0.94 parts of sulfuric acid was added to the cellulose that had been subjected to the first activating step, and the mixture was allowed to stand at 24°C for 45 minutes (second activating step). In addition, 417.85 parts of acetic acid, 282.98 parts of acetic anhydride, and 8.72 parts of sulfuric acid were mixed into the activated cellulose that had been subjected to the second activating step. The mixture was then maintained at a temperature of not higher than 15°C for 20 minutes, after which the temperature of the reaction system was increased to 35°C at a rate of temperature increase of 0.3 1°C/min and then maintained at 35°C for 80 minutes, and the material was acetylated. Furthermore, 0.15 parts by weight of acetic acid, 22.98 parts by weight of water, and 7.30 parts by weight of magnesium acetate were mixed and maintained at a temperature of 61°C for 95 minutes, after which 7.48 parts by weight of magnesium acetate, 20.94 parts by weight of acetic acid, and 21.44 parts of water were added, and the aging reaction was stopped. The reaction bath was charged into a dilute acetic acid under stirring, and the product was precipitated and immersed in a dilute aqueous solution of calcium hydroxide, and then separated by filtration and dried, and cellulose acetate was obtained.

[0139] An amount of 7.5 parts by weight of the obtained cellulose acetate with a degree of substitution of 2.81 was heated at 110°C for 2 hours and dried, after which the cellulose acetate was added to 90 parts by weight of acetone, stirred at 25°C for 6 hours, and dissolved. To this mixed solution, 2.5 parts by weight of triacetin, which is a water-soluble additive, was added as an additive, the mixture was further stirred at 25°C for 6 hours, and a dope was thereby prepared. After the dope was prepared, a film was obtained in the same manner as in Example 13. The physical properties were each evaluated using this film as an evaluation film. The results are shown in Table 1.

[Table 1]

	Cellulose Acetate					Additive		Thermal Stability		Endothermic Properties		Biodegradability		
	Total degree of acetyl substitution	DS6	DS2+3	τ	Sulfuric acid component amount (ppm)	Type	Content (wt.%)	Glass transition temperature (Tg) (°C)	Rate of increase air-flow resistance [%]	Equilibrium moisture amount (%)	Average temperature reduction rate of water vapor (%)	0 days	90 days	180 days
Example 1	2.46	0.74	1.72	2.32	30	-	-	-	-	-	-	0	27	70
Example 2	2.48	0.79	1.69	2.13	50	-	-	-	-	-	-	0	26	69
Example 3	2.46	0.74	1.72	2.32	140	-	-	-	-	-	-	0	27	67
Example 4	2.45	0.73	1.72	2.35	180	-	-	-	-	-	-	0	28	70
Example 5	2.45	0.73	1.72	2.35	350	-	-	190	-	-	-	0	29	69
Example 6	2.44	0.75	1.69	2.25	200	-	-	-	-	-	-	0	31	73
Example 7	2.42	0.78	1.64	2.10	380	-	-	-	-	-	-	0	33	76
Example 8	2.20	0.67	1.53	2.28	150	-	-	-	-	-	-	0	64	91
Example 9	2.46	0.74	1.72	2.32	140	Mg aluminometasilicate	5	-	-	-	-	0	37	76
Example 10	2.49	0.74	1.72	2.32	140	MgO	4	-	-	-	-	0	79	98
Example 11	2.46	0.74	1.72	2.32	140	Triacetin	25	-	-	-	-	0	33	84
Example 12	2.46	0.74	1.72	2.32	140	MgO + triacetin	MgO 5 Triacetin 20	-	-	-	-	0	95	99
Example 13	2.45	0.73	1.72	2.35	350	Triacetin	25	125	2.50	5.2	10.2	-	-	-
Example 14	2.20	0.67	1.53	2.28	150	Triacetin	25	144	-	6.1	12.2	-	-	-
Comparative Example 1	-	-	-	-	-	-	-	60	20.00	0.3	4.3	-	-	-
Comparative Example 2	2.81	0.90	1.91	2.12	200	Triacetin	25	-	-	1.0	8.4	-	-	-

[Table 2]

	n	Air-flow Resistance (mmWG)		Air-flow Resistance Increase Rate (%)
		Prior to water vapor passage	After water vapor passage	
Example 13	1	7	7	0.00
	2	8	7	12.50
	3	4	4	0.00
	4	6	6	0.00
	5	6	6	0.00
		Average		2.50
Comparative Example 1	1	4	3	25.00
	2	4	4	0.00
	3	4	3	25.00
	4	4	3	25.00
	5	4	3	25.00
		Average		20.00

[0140] The polylactic acid of Comparative Example 1 exhibited poor biodegradability, as it is so known, and was also inferior in thermal stability and endothermic properties as shown in Table 1. Furthermore, in the case of Comparative Example 2 in which cellulose acetate having a high total degree of acetyl substitution was included, the aerosol cooling member had a low equilibrium moisture ratio and a low average temperature decrease rate for the water vapor, and was thus inferior in endothermic properties. On the other hand, the aerosol cooling members of the examples exhibited excellent thermal stability, endothermic properties, and biodegradability (in particular, biodegradability in seawater). By using the aerosol cooling member of the examples as a cooling member for a smoking tool, the flow channel is less likely to be obstructed because deformation due to heat from the aerosol generated from the smoking tool does not easily occur, and thus a cooling member with an excellent aerosol cooling effect can be provided, and the environmental load can be reduced even when the smoking tool is discarded in the environment.

Claims

1. An aerosol cooling member comprising cellulose acetate having a total degree of acetyl substitution of greater than 1.4 to not greater than 2.7.
2. The aerosol cooling member according to claim 1, wherein a glass transition temperature is 70°C or higher.
3. The aerosol cooling member according to claim 1 or 2, having a marine biodegradability performance of 50% or greater for 180 days as measured in accordance with ASTM D6691.
4. The aerosol cooling member according to any one of claims 1 to 3, wherein the cellulose acetate has: τ of not less than 2.0, τ being a ratio of a sum of a degree of acetyl substitution at a 2-position and a degree of acetyl substitution at a 3-position to a degree of acetyl substitution at a 6-position in terms of the total degree of acetyl substitution; and a sulfuric acid component amount of greater than 20 ppm and not greater than 400 ppm.
5. The aerosol cooling member according to claim 4, wherein the sulfuric acid component amount in the cellulose acetate is from 80 ppm to 380 ppm.
6. The aerosol cooling member according to claim 4, wherein the sulfuric acid component amount in the cellulose acetate is from 150 ppm to 350 ppm.

7. The aerosol cooling member according to any one of claims 4 to 6, wherein the cellulose acetate has τ of not greater than 2.5, τ being a ratio of a sum of a degree of acetyl substitution at a 2-position and a degree of acetyl substitution at a 3-position to a degree of acetyl substitution at a 6-position in terms of the total degree of acetyl substitution.
8. The aerosol cooling member according to any one of claims 1 to 7, further comprising an additive, wherein the additive is one or more selected from the group consisting of: a material for which a pH of a 1 wt.% aqueous solution thereof at 20°C is 8 or higher; a material that dissolves at an amount of not less than 2 wt.% in water at 20°C; and a material having excellent biodegradability in the ocean.
9. The aerosol cooling member according to claim 8, wherein a content of the additive is from 4 to 40 wt.%.
10. The aerosol cooling member according to claim 8 or 9, wherein the material for which a pH of a 1 wt.% aqueous solution thereof at 20°C is 8 or higher is magnesium oxide.
11. The aerosol cooling member according to claim 8 or 9, wherein the material that dissolves at an amount of not less than 2 wt.% in water at 20°C is triacetin.
12. The aerosol cooling member according to any one of claims 1 to 11, which is fibrous, film shaped, particle shaped, a porous structure or tubular.
13. The aerosol cooling member according to any one of claims 1 to 11, which is in a fibrous tow form having a denier per filament from 0.6 tex to 3.5 tex and a total denier from 1000 tex to 4500 tex.
14. The aerosol cooling member according to any one of claims 1 to 12, which is a film, having an average temperature decrease rate of water vapor of 5% or greater as measured under Conditions below:
Conditions: a film-shaped aerosol cooling member having a length of 23.3 cm, a width of 17 mm, and a thickness of 50 μm is inserted into a tube made of polytetrafluoroethylene and having an inner diameter of 7 mm and a length of 17 mm, water vapor having a temperature of approximately 70°C immediately before passing through the tube is continuously passed through the inside of the tube at a constant flow rate 35 ml/min, and the temperature (°C) of the water vapor immediately before passing through the tube and the temperature (°C) of the water vapor immediately after passing through the tube are measured every 1 second for 120 seconds; an average value of the temperature decrease rate (%) of the water vapor for 120 seconds, as calculated by formulas below, is taken as the average temperature decrease rate of the water vapor:

$$\text{Temperature Decrease Rate (\%)} \text{ of Water Vapor} = \frac{[(\text{Temperature (}^\circ\text{C)} \text{ of water vapor immediately before passing through the tube)} - (\text{Temperature (}^\circ\text{C)} \text{ of water vapor immediately after passing through the tube)}]}{(\text{Temperature (}^\circ\text{C)} \text{ of water vapor immediately before passing through the tube)}} \times 100.$$



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EP 21 18 5285

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