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(54) Title: CATIONIC CROSSLINKED NON-WAXY STARCH PRODUCTS, A METHOD FOR PRODUCING THE STARCH PRODUCTS, AND USE IN PAPER PRODUCTS

(57) Abstract: There are disclosed cationic crosslinked non-waxy starch products having a Brookfield viscosity of about 700 cps to about 2500 cps and a method for preparing the starch products. Also disclosed is the use of the cationic crosslinked non-waxy starch products having a Brookfield viscosity of about 700 cps to about 2500 cps in the production of paper products.

CATIONIC CROSSLINKED NON-WAXY STARCH PRODUCTS, A METHOD FOR PRODUCING THE STARCH PRODUCTS, AND USE IN PAPER PRODUCTS

FIELD OF THE INVENTION

[0001] The present invention is generally directed to cationic crosslinked non-waxy starch products and their uses. Embodiments of the invention encompass cationic crosslinked non-waxy starch products, a method for producing the starch products, and paper products incorporating the cationic crosslinked non-waxy starch products.

BACKGROUND

[0002] It is well known that paper products may be improved as a result of incorporating various additives. Cationic crosslinked starches are known as having an ability to improve properties such as dry strength of paper products, and an ability to improve the papermaking process by improving retention and drainage. Cationic crosslinked starches are well known products.

[0003] US Patent Number 5,122,231 relates to cationic crosslinked starch products, that may include non-waxy starch products. The emphasis in this patent is related to cationic crosslinked dent starch products. The patent also describes the use of the cationic crosslinked starch products in the production of paper products. The cationic crosslinked starch products are required to have a hot paste Brookfield viscosity of about 500 cps to about 3000 cps as measured at a 1.0 Baume slurry solids which equates to 2.0% dry solids.

[0004] US Patent Number 5,368,690 relates to cationic crosslinked starch products that are useful in the production of paper. The cationic crosslinked starch products are described as having a Brabender breakdown viscosity of 2 to 85%, which relates to the extent of crosslinking level.

[0005] It would therefore be desirable to provide new cationic crosslinked non-waxy starch products that are expected to enhance the processing of paper products and the properties of the resultant paper products.

SUMMARY OF THE INVENTION

[0006] Various embodiments of the present invention are directed to cationic crosslinked non-waxy starch products, paper products incorporating such starch products, and methods of using such products. One embodiment provides a cationic crosslinked non-waxy starch product having a Brookfield viscosity ranging from about 700 cps to about 2500 cps (Centipoise) as measured in accordance with CRA Method B-54 at 0.5% solids using spindle number 21 at 20 rpm (revolutions per minute) and at a temperature of 97 °C. Another embodiment of the invention is further directed to a method for producing such cationic crosslinked non-waxy starch products. Further embodiments of the invention are directed to the use of such cationic crosslinked non-waxy starch products in the preparation of paper products and to paper products so made.

DETAILED DESCRIPTION OF THE INVENTION

[0007] Various embodiments of the present invention are directed to cationic crosslinked non-waxy starch products, paper products incorporating such starch products, and methods of using such products. One embodiment provides a cationic crosslinked non-waxy starch product having a Brookfield viscosity ranging from about 700 cps to about 2500 cps (Centipoise) as measured in accordance with CRA Method B-54 at 0.5% solids using spindle number 21 at 20 rpm (revolutions per minute) and at a temperature of 97 °C. Another embodiment of the invention is further directed to a method for producing such cationic crosslinked non-waxy starch products. Further embodiments of the invention are directed to the use of such cationic crosslinked non-waxy starch products in the preparation of paper products and to paper products so made.

[0008] In more detail, the cationic crosslinked non-waxy starch product having a Brookfield viscosity ranging from about 700 cps to about 2500 cps as measured in accordance with CRA Method B-54 at 0.5% solids using spindle number 21 at 20 rpm and at a temperature of 97 °C, is described as follows. The non-waxy starch may be derived from any suitable source such as non-waxy corn starch, non-waxy potato starch, non-waxy sweet potato, non-waxy wheat starch, non-waxy sago starch, non-waxy sorghum starch, non-waxy tapioca starch, non-waxy rice starch, and mixtures thereof. Non-waxy starch is defined herein as starch containing both amylose and amylopectin.

[0009] Non-waxy starch products in embodiments of the present invention have a Brookfield viscosity ranging from about 700 cps to about 2500 cps as measured in accordance with CRA Method B-54 at 0.5% solids using spindle number 21 at 20 rpm and at a temperature of 97 °C. In a preferred embodiment, the Brookfield viscosity ranges from about 800 cps to about 2000 cps. In a more preferred embodiment, the Brookfield viscosity ranges from about 1000 cps to about 1500 cps. The test procedure for determining the Brookfield viscosity is described herein.

[0010] In producing the cationic crosslinked non-waxy starch products of the present invention, any conventional method may be used such as those disclosed in US Patent Number 5,122,231 and US Patent Number 5,368,690 that relate to methods for preparing cationic crosslinked starches. For example, any non-waxy starch may be cationized and crosslinked, in either order or simultaneously, and the reaction may be allowed to proceed under conditions to produce a cationic, crosslinked non-waxy starch having a Brookfield viscosity ranging from about 700 cps to about 2500 cps as measured in accordance with CRA Method B-54 at 0.5% solids using spindle number 21 at 20 rpm and at a temperature of 97 °C. Preferably, the process is carried out under conditions that will produce a cationic crosslinked non-waxy starch having a viscosity of from about 800 cps to about 2000 cps, and more preferably, from about 1000 cps to about 1500 cps. The non-waxy starch utilized in the process may be any of the non-waxy starches identified above. In one useful embodiment, the non-waxy starch is non-waxy corn starch. While any cationizing agent may be utilized in the process, it is preferred that the cationizing reaction be achieved utilizing a component selected from an amino ion, imino ion, sulfonium ion, phosphonium ion, ammonium ion and mixtures thereof, preferably, a quaternary ammonium ion. Though many crosslinking agents are suitable for use in the present process, embodiments of the invention utilize a component selected from a multi-functional etherifying agent, a multi-functional esterifying agent and mixtures thereof. Suitable crosslinking agents for select embodiments are epichlorohydrin, a dicarboxylic anhydride, phosphorous oxychloride, an alkali earth metal salt of trimetaphosphate, a linear mixed anhydride, a polyamine polyepoxide resin and mixtures thereof. One preferred embodiment employs an alkali earth metal salt of trimetaphosphate as the crosslinking agent.

[0011] In one embodiment, preparing the cationic crosslinked non-waxy starch products includes generally monitoring the reaction for completion by measuring the viscosity to ensure that

the viscosity value ranges from about 700 cps to about 2500 cps as measured by the test procedure herein. When the viscosity is determined to fall within the desired range, the reaction may be terminated.

[0012] A non-waxy starch, as described herein, is cationized by reacting the non-waxy starch with any cationizing agent. Exemplary of the cationizing agents are agents having amino ions, imino ions, sulfonium ions, phosphonium ions, or ammonium ions and mixtures thereof. The cationizing reaction may be carried out in any conventional manner such as reacting the non-waxy starch in an aqueous slurry form with the cationizing agent, usually in the presence of an activating agent such as sodium hydroxide. Another process that may be used is a semi-dry process where the non-waxy starch is reacted with the cationizing reagent in the presence of an activating agent such as sodium hydroxide, in a limited amount of water.

[0013] In one embodiment, the cationizing agent has an ammonium ion, and preferably, the ammonium ion is a quaternary ammonium ion. One particularly useful embodiment employs (3-chloro-2-hydroxypropyl)trimethylammonium chloride as a cationizing agent.

[0014] The cationic crosslinked non-waxy starch products, as described herein, are crosslinked by reacting the non-waxy starch with any crosslinking agent. The reaction is carried out using any known manner for crosslinking a product. Suitable crosslinking agents for some embodiments include, but are not limited to, a multi-functional etherifying agent, a multi-functional esterifying agent, mixtures thereof, and the like. Specific examples of suitable crosslinking agents include, but are not limited to, epichlorohydrin, a dicarboxylic anhydride, phosphorous oxychloride, an alkali earth metal salt of trimetaphosphate, a linear mixed anhydride, a polyamine polyepoxide resin, mixtures thereof, and the like. The crosslinking reaction may be carried out in any conventional manner such as reacting the non-waxy starch in an aqueous slurry form with the crosslinking agent, usually in the presence of an activating agent such as sodium hydroxide. Another crosslinking process that may be used is a semi-dry process where the non-waxy starch is reacted with the crosslinking agent in the presence of an activating agent such as sodium hydroxide, in a limited amount of water.

[0015] The non-waxy starch may be cationized and crosslinked in any order, in producing the cationic crosslinked non-waxy starch. For example, the starch may be cationized then crosslinked, or the starch may be crosslinked then cationized. Furthermore, the cationizing agent and the crosslinking agent may be utilized simultaneously.

[0016] Some embodiments of the invention employ cationic crosslinked non-waxy starch products in the production of paper. The cationic crosslinked non-waxy starch products may be incorporated in the production of paper using any conventional manner. For example, the cationic crosslinked non-waxy starch products may be slurried in water and the resultant slurry heated at a temperature sufficient to achieve gelatinization of the starch slurry to produce a gelatinized starch paste. Typically, the heating to achieve gelatinization is carried out at a temperature above about 90 °C. The gelatinized starch paste may then be applied to a cellulosic suspension, particularly a paper furnish, in any known manner. In doing so, the gelatinized starch paste may be applied to the wet-end of a paper machine in a paper fiber thick stock, or a paper fiber thin stock, or a split addition to both the thick stock and thin stock. In applying the gelatinized starch paste to the cellulosic suspension, any amount of starch may be incorporated as desired. Typically, the amount of cationic crosslinked non-waxy starch to be incorporated ranges from about 0.1% to about 5% by weight based on the paper fiber. In a preferred embodiment, the cationic crosslinked non-waxy starch product is present in an amount ranging from about 0.5% to about 2% by weight based on the weight of the fiber.

[0017] Furthermore, if desired, conventional additives may be utilized in producing the paper products. For example, there may be incorporated dyes, pigments, sizing additives, retention and drainage aids, aqueous suspensions or solutions of biopolymers or synthetic polymers, and the like.

[0018] Cationic crosslinked non-waxy starch products in accordance with aspects of the present invention are expected to have utility in fields other than papermaking. Such applications would include, for example, food container manufacture, production of paints, flocculation of aqueous suspensions as in water treatment and ore purification, and the like.

[0019] The following examples are presented to illustrate aspects of the present invention and to assist one of ordinary skill in making and using the same. The examples are not intended in any way to otherwise limit the scope of the invention.

EXAMPLES

[0020] The following test procedures are utilized in evaluating the properties of the cationic crosslinked non-waxy starch products, and the paper products, provided in the examples.

[0021] TEST PROCEDURES

[0022] Brookfield Viscosity

[0023] Brookfield viscosity of a cationic crosslinked non-waxy starch was determined in accordance with the Standard Analytical Methods of the Corn Refiners Association, Inc. Test Procedure CRA Method B-54 with the conditions specified herein. The instrument utilized in determining viscosity was a Brookfield DV-II+ Viscometer. The test procedure was conducted by cooking a sample, at a hot water bath temperature setting of 97 °C, for 10 minutes using spindle number 21 at 20 revolutions per minute. The Brookfield viscosity of the cationic crosslinked starch, which is in the form of a hot paste, was determined using a solids level of 0.5%.

[0024] STARCH PRODUCTS

[0025] Example 1

[0026] Cationic crosslinked non-waxy corn starch having a Brookfield viscosity within the range of 700 cps to 2500 cps is prepared by charging a reactor with non-waxy corn starch slurry, sodium hydroxide, and (3-chloro-2-hydroxypropyl) trimethylammonium. The slurry is then heated and allowed to react for a required period of time to achieve a desired nitrogen substitution. After the nitrogen substitution is achieved, a sample of the slurry is measured to ensure that the pH of the reaction slurry was at 11.2. If necessary, the pH is adjusted to 11.2. Sodium trimetaphosphate is

added in one portion to the slurry and the slurry is allowed to react for a designated period of time. The slurry is brought to a pH of about 7 by the addition of an acid solution. The slurry is then washed, de-watered, and dried to a desired moisture level. The viscosity of the resulting cationic crosslinked non-waxy starch is determined by the Brookfield viscosity procedure herein.

[0027] Example 2

[0028] An alternative embodiment of producing the cationic crosslinked non-waxy starch of the present invention is as follows. Semi-dry non-waxy corn starch, having a moisture level of 10-30% is mixed with 2,3-epoxypropyl-N,N,N,-trimethylammonium chloride, and 1,3-dichloro-2-propanol in the presence of sodium hydroxide as an activating agent. It is expected that there will be obtained cationic crosslinked non-waxy corn starch having a Brookfield viscosity ranging from about 700 cps to about 2500 cps as measured in accordance with CRA Method B-54 at 0.5% solids using spindle number 21 at 20 rpm and at a temperature of 97 °C.

[0029] Example 3

[0030] The process according to Example 1 is followed with the exception that (3-chloro-2-hydroxypropyl)trimethylammonium chloride is replaced by (3-chloro-2-hydroxypropyl)dimethyldodecylammonium chloride. It is expected that there will be obtained cationic crosslinked non-waxy starch product having a Brookfield viscosity ranging from about 700 cps to about 2500 cps as measured in accordance with CRA Method B-54 at 0.5% solids using spindle number 21 at 20 rpm and at a temperature of 97 °C.

[0031] Example 4

[0032] The process according to Example 1 is followed with the exception that (3-chloro-2-hydroxypropyl)trimethylammonium chloride is replaced by (3-chloro-2-hydroxypropyl)dimethyloctadecylammonium chloride. It is expected that there will be obtained cationic crosslinked non-waxy starch product having a Brookfield viscosity ranging from about 700 cps to about 2500 cps as measured in accordance with CRA Method B-54 at 0.5% solids using

spindle number 21 at 20 rpm and at a temperature of 97 °C.

[0033] Example 5

[0034] The process according to Example 1 is followed with the exception that the sodium trimetaphosphate is replaced by 1,2,4,5-benzenetetracarboxylic dianhydride and is reacted at a pH range of 8-10. It is expected that there will be obtained cationic crosslinked non-waxy starch product having a Brookfield viscosity ranging from about 700 cps to about 2500 cps as measured in accordance with CRA Method B-54 at 0.5% solids using spindle number 21 at 20 rpm and at a temperature of 97 °C.

[0035] Example 6

[0036] The process according to Example 1 is followed with the exception that the non-waxy corn starch is replaced by non-waxy rice starch. It is expected that there will be obtained cationic crosslinked non-waxy starch product having a Brookfield viscosity ranging from about 700 cps to about 2500 cps as measured in accordance with CRA Method B-54 at 0.5% solids using spindle number 21 at 20 rpm and at a temperature of 97 °C.

[0037] Example 7

[0038] The process according to Example 1 is followed with the exception that the non-waxy corn starch is replaced by non-waxy tapioca starch. It is expected that there will be obtained cationic crosslinked non-waxy starch product having a Brookfield viscosity ranging from about 700 cps to about 2500 cps as measured in accordance with CRA Method B-54 at 0.5% solids using spindle number 21 at 20 rpm and at a temperature of 97 °C.

[0039] Example 8

[0040] The process according to Example 1 is followed with the exception that the non-waxy corn starch is replaced by non-waxy potato starch. It is expected that there will be obtained cationic crosslinked non-waxy starch product having a Brookfield viscosity ranging from about 700 cps to about 2500 cps as measured in accordance with CRA Method B-54 at 0.5% solids using spindle number 21 at 20 rpm and at a temperature of 97 °C.

[0041] Example 9

[0042] The process according to Example 1 is followed with the exception that the non-waxy corn starch is replaced by non-waxy sorghum starch. It is expected that there will be obtained cationic crosslinked non-waxy starch product having a Brookfield viscosity ranging from about 700 cps to about 2500 cps as measured in accordance with CRA Method B-54 at 0.5% solids using spindle number 21 at 20 rpm and at a temperature of 97 °C.

[0043] PAPER PRODUCTS

[0044] Example 10

[0045] In this example there is shown the incorporation of a cationic crosslinked non-waxy corn starch product prepared in Example 1, in the preparation of a paper product. In this example, the starch product is utilized in the form of a gelatinized paste. The paper is prepared using a standard Fourdrinier paper machine. The hardwood/softwood bleached fiber is added to a coated broke furnish at the blend chest along with ground calcium carbonate and thick stock alum in conventional amounts. The furnish mixture is further diluted with water, followed by the addition of a starch paste. Before the headbox, silica and trim alum in conventional amounts are added and the furnish is pumped to the headbox for distribution onto the paper machine wire. The paper web is then dried and wound on a roll.

[0046] Example 11

[0047] In this example the procedure of Example 10 is followed with the exception that the cationic crosslinked non-waxy corn starch of Example 1 is replaced by the cationic crosslinked non-waxy corn starch of Example 2. It is expected that there will be obtained a suitable paper product.

[0048] Example 12

[0049] In this example the procedure of Example 10 is followed except that the cationic crosslinked non-waxy corn starch of Example 1 is replaced by, respectively, the cationic crosslinked non-waxy corn starch products of Examples 3, 4, and 5. It is expected that there will be obtained suitable paper products. In these instances it is further expected that the paper product produced using the starch products of Examples 3, 4, and 5 will be characterized by increased internal sizing.

[0050] Example 13

[0051] In this example the procedure of Example 10 is followed with the exception that the cationic crosslinked non-waxy corn starch of Example 1 is replaced by the cationic crosslinked non-waxy rice starch product of Example 6. It is expected that there will be obtained a suitable paper product.

[0052] Example 14

[0053] In this example the procedure of Example 10 is followed with the exception that the cationic crosslinked non-waxy corn starch of Example 1 is replaced by the cationic crosslinked non-waxy tapioca starch product of Example 7. It is expected that there will be obtained a suitable paper product.

[0054] Example 15

[0055] In this example the procedure of Example 10 is followed with the exception that the cationic crosslinked non-waxy corn starch of Example 1 is replaced by the cationic crosslinked non-

waxy potato starch product of Example 8. It is expected that there will be obtained a suitable paper product.

[0056] Example 16

[0057] In this example the procedure of Example 10 is followed with the exception that the cationic crosslinked non-waxy corn starch of Example 1 is replaced by the cationic crosslinked non-waxy sorghum starch product of Example 9. It is expected that there will be obtained a suitable paper product.

[0058] The invention has been described with reference to various specific and illustrative embodiments and techniques. However, one skilled in the art will recognize that many variations and modifications may be made while remaining within the spirit and scope of the invention. The entirety of each of the patents and other references identified above is incorporated herein by reference.

CLAIMS

What is claimed is:

1. A cationic crosslinked non-waxy starch product having a Brookfield viscosity ranging from about 700 cps to about 2500 cps as measured in accordance with CRA Method B-54 at 0.5% solids using spindle number 21 at 20 rpm and at a temperature of 97 °C.

2. The cationic crosslinked non-waxy starch product according to claim 1 wherein the non-waxy starch is selected from the group consisting of non-waxy corn starch, non-waxy potato starch, non-waxy sweet potato starch, non-waxy wheat starch, non-waxy sago starch, non-waxy sorghum starch, non-waxy tapioca starch, non-waxy rice starch, and mixtures thereof.

3. The cationic crosslinked non-waxy starch product according to claim 2 wherein the non-waxy starch is non-waxy corn starch.

4. The cationic crosslinked non-waxy starch product according to claim 2 wherein the non-waxy starch is non-waxy potato starch.

5. The cationic crosslinked non-waxy starch product according to claim 2 wherein the non-waxy starch is non-waxy tapioca starch.

6. The cationic crosslinked non-waxy starch product according to claim 1 wherein the product has a Brookfield viscosity ranging from about 800 cps to about 2000 cps.

7. The cationic crosslinked non-waxy starch product according to claim 1 wherein the product has a Brookfield viscosity ranging from about 1000 cps to about 1500 cps.

8. The cationic crosslinked non-waxy starch product according to claim 1 wherein the non-waxy starch is cationized by reaction with a component selected from the group consisting of an amino ion, imino ion, sulfonium ion, phosphonium ion, ammonium ion and mixtures thereof.

9. The cationic crosslinked non-waxy starch product according to claim 8 wherein the non-waxy starch is cationized by reaction with an ammonium ion wherein the ammonium ion is a quaternary ammonium ion.

10. The cationic crosslinked non-waxy starch product according to claim 9 wherein the non-waxy starch is cationized by reaction with (3-chloro-2-hydroxypropyl) trimethylammonium chloride.

11. The cationic crosslinked non-waxy starch product according to claim 1 wherein the non-waxy starch is crosslinked by reaction with a component selected from the group consisting of a multi-functional etherifying agent, a multi-functional esterifying agent and mixtures thereof.

12. The cationic crosslinked non-waxy starch product according to claim 1 wherein the non-waxy starch is crosslinked by reaction with a component selected from the group consisting of epichlorohydrin, a dicarboxylic anhydride, phosphorous oxychloride, an alkali earth metal salt of trimetaphosphate, a linear mixed anhydride, a polyamine polyepoxide resin and mixtures thereof.

13. The cationic crosslinked starch product according to claim 1 wherein the non-waxy starch is cationized by reaction with (3-chloro-2-hydroxypropyl)trimethyl-ammonium chloride, and the non-waxy starch is crosslinked by reaction with at least one alkali earth metal salt of trimetaphosphate.

14. A paper product comprising a cationic crosslinked non-waxy starch product having a Brookfield viscosity ranging from about 700 cps to about 2500 cps as measured in accordance with CRA Method B-54 at 0.5% solids using spindle number 21 at 20 rpm and at a temperature of 97 °C.

15. The paper product according to claim 14 wherein the non-waxy starch is selected from the group consisting of non-waxy corn starch, non-waxy potato starch, non-waxy sweet potato starch, non-waxy wheat starch, non-waxy sago starch, non-waxy sorghum starch, non-waxy tapioca starch, non-waxy rice starch, and mixtures thereof.

16. The paper product according to claim 15 wherein the non-waxy starch is non-waxy corn starch.

17. The paper product according to claim 15 wherein the non-waxy starch is non-waxy potato starch.

18. The paper product according to claim 15 wherein the non-waxy starch is non-waxy tapioca starch.

19. The paper product according to claim 14 wherein the cationic crosslinked non-waxy starch product has a Brookfield viscosity ranging from about 800 cps to about 2000 cps.

20. The paper product according to claim 14 wherein the cationic crosslinked non-waxy starch product has a Brookfield viscosity ranging from about 1000 cps to about 1500 cps.

21. The paper product according to claim 14 wherein the non-waxy starch is cationized by reaction with a component selected from the group consisting of an amino ion, imino ion, sulfonium ion, phosphonium ion, ammonium ion and mixtures thereof.

22. The paper product according to claim 21 wherein the non-waxy starch is cationized by reaction with an ammonium ion wherein the ammonium ion is a quaternary ammonium ion.

23. The paper product according to claim 22 wherein the non-waxy starch is cationized by reaction with (3-chloro-2-hydroxypropyl)trimethylammonium chloride.

24. The paper product according to claim 14 wherein the non-waxy starch is crosslinked by reaction with a component selected from the group consisting of a multi-functional etherifying agent, a multi-functional esterifying agent and mixtures thereof.

25. The paper product according to claim 14 wherein the non-waxy starch is crosslinked by reaction with a component selected from the group consisting of epichlorohydrin, a dicarboxylic anhydride, phosphorous oxychloride, an alkali earth metal salt of

trimetaphosphate, a linear mixed anhydride, a polyamine polyepoxide resin and mixtures thereof.

26. The paper product according to claim 14 wherein the non-waxy starch is cationized by reaction with (3-chloro-2-hydroxypropyl)trimethylammonium chloride, and the non-waxy starch is crosslinked by reaction with at least one alkali earth metal salt of trimetaphosphate.

27. The paper product according to claim 14 wherein the cationic crosslinked non-waxy starch product is present in an amount ranging from about 0.1% to about 5% by weight based on the weight of fiber.

28. The paper product according to claim 27 wherein the cationic crosslinked non-waxy starch product is present in an amount ranging from about 0.5% to about 2% by weight.

29. A process for preparing a cationic crosslinked non-waxy starch product having a Brookfield viscosity ranging from about 700 cps to about 2500 cps as measured in accordance with CRA Method B-54 at 0.5% solids using spindle number 21 at 20 rpm and at a temperature of 97 °C comprising cationizing a non-waxy starch, crosslinking the non-waxy starch, and reacting under conditions to prepare the cationic crosslinked non-waxy starch product having a Brookfield viscosity ranging from about 700 cps to about 2500 cps as measured in accordance with CRA Method B-54 at 0.5% solids using spindle number 21 at 20 rpm and at a temperature of 97 °C.

30. The process according to claim 29 wherein the cationic crosslinked non-waxy starch product has a Brookfield viscosity ranging from about 800 cps to about 2000 cps.

31. The process according to claim 29 wherein the cationic crosslinked non-waxy starch product has a Brookfield viscosity ranging from about 1000 cps to about 1500 cps.

32. The process according to claim 29 wherein the non-waxy starch is selected from the group consisting of non-waxy corn starch, non-waxy potato starch, non-waxy sweet

potato starch, non-waxy tapioca starch, non-waxy rice starch, non-waxy sago starch, non-waxy sorghum starch, and mixtures thereof.

33. The process according to claim 29 wherein the non-waxy starch is cationized by reaction with a component selected from the group consisting of an amino ion, imino ion, sulfonium ion, phosphonium ion, ammonium ion and mixtures thereof.

34. The process according to claim 29 wherein the non-waxy starch is crosslinked by reaction with a component selected from the group consisting of a multi-functional etherifying agent, a multi-functional esterifying agent and mixtures thereof.

35. The process according to claim 29 wherein the non-waxy starch is crosslinked by reaction with a component selected from the group consisting of epichlorohydrin, a dicarboxylic anhydride, phosphorous oxychloride, an alkali earth metal salt of trimetaphosphate, a linear mixed anhydride, a polyamine polyepoxide resin and mixtures thereof.

36. The process according to claim 29 wherein the non-waxy starch is cationized by reaction with (3-chloro-2-hydroxypropyl)trimethylammonium chloride, and the non-waxy starch is crosslinked by reaction with at least one alkali earth metal salt of trimetaphosphate.

INTERNATIONAL SEARCH REPORT

International Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C08B31/00 C08B31/12 D21H17/29

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C08B D21H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 122 231 A (ANDERSON ET AL) 16 June 1992 (1992-06-16) cited in the application	1-4, 6-12, 14-17, 19-25, 27-35
Y	column 4, lines 32-39; claim 1; example IV column 3, lines 58-60	5,13,18, 26,36
Y	WO 97/46591 A (GEORGE WESTON FOODS LIMITED; NEALE, RAYMOND, BEDE; NEWLAND, GERALD, L) 11 December 1997 (1997-12-11) claims 10,20; example A	5,13,18, 26,36

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[X] Further documents are listed in the continuation of box C.

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INTERNATIONAL SEARCH REPORT

International Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	QUAN Y ET AL: "EFFECT OF CROSS LINKING ON FUNCTIONAL PROPERTIES OF CATIONIC CORN STARCH" STARKE - STARCH, WILEY-VCH, WEINHEIM, DE, vol. 49, no. 11, November 1997 (1997-11), pages 458-464, XP000725994 ISSN: 0038-9056 page 489, left-hand column; figure 4	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US2005/015567

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5122231 A	16-06-1992	NONE	
WO 9746591 A	11-12-1997	AU 712167 B2	28-10-1999
		AU 2758997 A	05-01-1998
		WO 9746591 A1	11-12-1997