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(54) **Reinforced paperboard.**

(57) This invention provides reinforced paperboard and articles made from such reinforced paperboard, wherein the paperboard and articles have improved strength properties. The reinforced paperboard is formed by impregnating one side of the paperboard with a liquid reinforcing composition, such as a latex material. The impregnation is continued until the reinforcing composition penetrates to a depth of from about 5 to about 25 percent of the paperboard tickness.

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Field of Invention

The present invention relates to reinforced paperboard, and to articles made from such reinforced paperboard. In accordance with this invention, the reinforced paperboard and the manufactured articles have improved strength properties.

Background of the Invention

In the manufacture of certain paperboard articles, specific areas of the article may require greater strengh properties than other areas. For example, the area around the handle of a beverage carton may require greater strength because of the downward force exerted by the beverage cans or bottles.

One method of handling the strength requirements is to manufacture the entire carton from a paperboard which has the necessary thickness to provide th strength requirements for the handle area. While this method may achieve the desired results, the obvious disadvantage is that paperboard is wasted in those areas which do not require additional strength and, consequently, the cost of the carton is increased.

Another method of handling this "selective strength" problem is shown in Hiscock et al. U.S. Patent No. 4,617,223, where the paperboard is reinforced only in the critical areas, which permits thinner paperboard to be used for the remaining areas of the article. Hiscock et al. disclose that selective reinforcement is achieved by impregnating the paperboard with a polyisocyanate material which can be applied by coating or printing techniques.

The prior art also discloses that paperboard may be impreganted with resins to increase certain properties, such as compressive strength, tensile strength, tearing strength, flexibility and moisture penetrability. For example, Igarashi et al. U.S. Patent No. 3,953,169 discloses the impregnation of paperboard with a particular polyisocyanate resin.

However, the prior art systems have disadvantages, such as the inability to select precisely the area(s) to be reinforced and the cost of the materials used for reinforcement. In some instances, the prior art systems do not provide a paperboard with the necessary strength improvements. Therefore, a need exists for a paperboard which has been reinforced to provide improved strength properties and which can be manufactured into articles having improved strength properties.

Summary of the Invention

The existing need as described above is met by the present invention which provides for reinforcing paperboard through impregnation with a liquid reinforcing composition, such as a latex material. The impregnation is accomplished through one side of the paperboard, and the reinforcing composition partially penetrates the paperboard. In accordance with this invention, the reinforcing composition does not penetrate the entire distance through the paperboard. The paperboard obtained with this invention may be selectively reinforced in only those areas which require greater strengh properties due to the intended use of articles manufactured from such paperboard.

Accordingly, an objet of this invention is to provide a reinforced paperboard.

Another object of this invention is to provide a reinforced paperboard having improved properties, such as wet and dry tear strengths.

Another object of this invention is to provide a reinforced paperboard which is reinforced only in selected areas.

Another object of this invention is to provide a reinforced paperboard in which the reinforcement is achieved with a liquid reinforcing composition, such as a latex material.

Another object of this invention is to provide a reinforced paperboard in which the reinforcement is achieved with a styrene-butadiene latex material.

Still another object of this invention is to provide a reinforced paperboard in which the reinforcement is achieved by impregnation through one side of the paperboard.

Still another object of this invention is to provide a reinforced paperboard in which the reinforcing composition partially penetrates the paperboard.

Still another object of this invention is to provide a reinforced paperboard in which the reinforcement is achieved by impregnation in a vacuum station.

Yet still another objet of this invention is to provide an article manufactured from such reinforced paperboard, wherein the article has improved strength properties.

These and other objects, features and advantages of this invention will become apparent from the following detailed description and claims.

Detailed Description of the Invention

In accordance with the present invention, a reinforced paperboard having improved properties, such as wet and dry tear strengths, is provided by impregnating the paperboard with a liquid reinforcing composition. The impregnation is accomplished through only one side of the paperboard, and the reinforcing composition only partially penetrates the paperboard.

The present invention may be used to reinforce various types of paperboard, the manufacture of which is well-known in the art. This invention is effective in reinforcing paperboard having a wide range of thicknesses.

Although various reinforcing compositions may be used to achieve the results of this invention, the presently preferred materials are the latexes, particularly the styrene-butadiene latexes. An especially preferred latex is the carboxylated styrene-butadiene polymer latex sold by The Dow Chemical Company (Midland, Michigan) under the trade designation Latex DL 238NA. This particular latex is a milky white liquid emulsion of the polymer and water, in which the polymer contains a bactericide and a stabilizer.

Other examples of styrene-butadiene latexes suitable for use in this invention are those materials sold by The Dow Chemical Company under the trade designations Latex DL 239, Latex DL 246 and Latex DL 328.

Examples of other reinforcing compositions suitable for use in this invention are (1) water-based acrylic materials, such as those sold by S. C. Johnson & Son, Inc. under the trade designations Versacryl 763 and Versacryl 766 and (2) compositions which primarily comprise a sodium silicate and water.

Additionally, this invention contemplates the use of a mixture of two or more materials as the reinforcing composition.

To aid in the handling and effectiveness of the reinforcing compositions of this invention, other additives may be used in such compositions. For example, an anti-blocking agent may be used to prevent blocking of the latex polymer. A preferred anti-blocking agent is an anionic co-emulsion of carnauba and paraffin waxes sold by Michelman, Inc. (Cincinnati, Ohio) under the trade designation Michemlube 182.

Another preferred additive for these reinforcing compositions is a solvent which aids in the coalescing of the latex polymers and which aids in the handling of these reinforcing compositions. Examples of preferred solvents are (1) a blend of diethylene glycol monoethyl ether and ethylene glycol sold by Eastman Chemical Products, Inc. (Kingsport, Tenessee) under the trade designation Ektasolve DE and (2) a blend of 1,1,1-trichloroethane and diethylene ether sold by The Dow Chemical Company under the trade designation Chlorothene SM.

Other additives may be used for various purposes, such as pigments, colorants, stabilizers, wetting agents, etc.

According to this invention, the paperboard may be impregnated with the reinforcing composition by any suitable means but a process and apparatus which involve a vacuum-impregnating technique are preferred.

In more specific terms, the objects and advantages of the present invention are achieved by moving the paperboard through a vacuum station in which only one side of the paperboard is subjected to a vacuum force. If a paperboard coated on one side is used, the uncoated side of the paperboard is subjected to the vacuum force. If an uncoated paperboard is used, a belt or other backing support should be used on the side to which the vacuum force is not applied, as is suggested for example, in U. S. Patent 3,766,756. With the interstices of the paperboard evacuated of air, the reinforcing composition is then applied to the same side, such as by dipping, spraying, rolling, etc. The vacuum force and reinforcing composition will be applied in a controlled fashion to achieve the desired degree of penetration into the paperboard.

Of course, the degree of penetration may vary and is dependent upon the vacuum force and the tickness of the paperboard. Generally, the reinforcing composition should penetrate the paperboard to a depth of from about 5 to about 25 percent of such tickness, preferably from about 10 to about 20 percent.

If selective reinforcement is desired, the vacuum force and the reinforcing composition will be applied only in those selected areas where such reinforcement is desired.

As noted earlier, a distinct advantage provided by this invention is the selective reinforcement of paperboard. Stated another way, this invention can be used to provide a paperboard which is reinforced only in those areas which require such reinforcement. For example, Wood U. S. Patent 4,558,816 discloses a can carton having a handle integral with the carton. The present invention can be used advantageously to reinforce the carton of the Wood patent in those areas around the handle where a greater force is exerted on the handle when the carton is lifted and/or carried.

As provided by this invention, the reinforced paperboard has improved properties as compared to the same paperboard which is not reinforced. These improved properties are especially apparent when the dry and wet tear strenghts are compared for the non-reinforced and reinforced paperboards. Additionally, improved strength properties are especially apparent in articles made from the reinforced paperboard of this invention when such articles are subjected to finished package tests, such as the integrity and drop tests.

The terms Dry Tear Strength, Wet Tear Strength, Dry Drops, Wet Drops, Dry Integrity and Wet Integrity used in this application are defined as follows:

Dry Tear Strength is determined by TAPPI Test Procedure No. T414-ts 65 and refers to the average force in grams required to tear a single sheet of paperboard after the tear has been started.

Wet Tear Strength is also determined by TAPPI Test Procedure No. T414-ts 65 and refers to the same measurement except that, prior to testing, the paperboard samples have been soaked in water for one hour.

Dry Drops is a finished package test developped by The Mead Corporation of Dayton, Ohio. In this test, the handle of a paperboard container with 24 cans is secured to a strap and suspended under the weight of the container. The container is then free-dropped successively for 1-1/2 inches until the handle fails. The test results refer to the number of drops until the handle fails.

Wet Drops is determined by the Dry Drops procedure except that the container is soaked in water for 3 minutes prior to testing.

Dry Integrity is determined by the Basket Integrity Test procedure as defined in the November 1982 revision of the Secondary Glass Packaging Voluntary Specification Guideline for Paperboard and Corrugated Board Packaging Systems as published by the Nation Soft Drink Association of Washington, D.C. The test results refer to the pounds of load pressure which the handle will sustain before failure. This test is further described in Watkins et al. U.S. Patent 4,046,000.

Wet Integrity is determined by the same Basket Integrity Test procedure except that the container is soaked in water for 3 minutes prior to testing.

This invention is further illustrated by the following example wich is illustrative of certain embodiments designed to teach those of ordinary skill in this art how to practice this invention and to represent the best mode contemplated for carrying out this invention.

In the following example, the paperboard is a conventional fibrous paperboard which is coated on one side, the preparation of which is well-known in the art.

Example

A sample is obtained of a conventional fibrous paperboard wich is coated on one side and wich can be used in the manufacture of beverage cartons. This non-reinforced sample is weighed and then tested for dry and wet tear strengths. The test results are shown in Table A.

Two additional samples of the same paperboard are obtained. These samples are first moved through a vacuum station where a vacuum force is applied to the uncoated sides to remove air and then moved through a second chamber in which the paperboard is impregnated with the following reinforcing composition:

Component	Percent by weight
Latex DL 238 NA	85.0
Michemlube 182	5.0
Ektasolve DE	10.0

Penetration of the reinforcing composition is effected to a depth of about 15 percent of the paperboard thickness.

The reinforced samples are weighed and then tested for dry and wet tear strengths. The test results are also shown in Table A.

Table A

	Non-Reinforced Sample	Reinforced Sample No. 1
Weight (lbs. per 1,000 sq. ft.)	74	82.6
Dry Tear Strength (machine direction)	430	496
Dry Tear Strength (cross direction)	512	650
Wet Tear Strength (machine direction)	347	514
Wet Tear Strength (cross direction)	394	626

As can be calculated from the test results shown in Table A, the dry and wet tear strengths (machine and cross directions) are substantially improved for the reinforced paperboard samples provided by the present invention.

Beverage cartons as described in Wood U.S. Patent 4,558,816 are manufactured from additional samples of the non-reinforced and reinforced paperboard. These cartons are then tested for the strength properties shown in Table B. These test results are the average of 10 tests.

Table B

	Non-Reinforced Carton (24 Cans)	Reinforced Carton (24 Cans)
Dry Drops (no. of drops)	8.4	20.8
Wet Drops (no. of drops)	2.2	6.4
Dry Integrity (lbs.)	109	135
Wet Integrity (lbs.)	81	100

As can be seen from Table B, the finished package test results are substantially improved for the cartons made from the reinforced paperboard provided by this invention.

Thus, these reinforced paperboard samples can be used to provide beverage can cartons having good durability because of the improved strength properties.

The foregoing description relates to certain embodiments of this invention, and modifications or alterations may be made without departing from the spirit and scope of this invention as set forth in the claims.

Claims

1. A process for reinforcing paperboard wherein the process comprises the sequential steps of:
   A. subjecting one side of the paperboard to a vacuum force to remove air from the paperboard matrix;
   B. applying to the same side of the paperboard a liquid reinforcing composition; and
   C. controlling the vacuum force so that the reinforcing composition penetrates to a depth of from about 5 to about 25 percent of the paperboard thickness.

2. A process as defined by Claim 1 wherein the paperboard is pre-coated on the side which is not subjected to the vacuum force.

3. A process as defined by Claim 1 wherein the reinforcing composition is applied to the paperboard only in selected areas.

4. A process as defined by Claim 1 wherein the liquid reinforcing composition comprises a latex material.

5. A process as defined by Claim 4 wherein the latex material is a styrene-butadiene latex material.

6. A process as defined by Claim 1 wherein the reinforcing composition consists essentially of a styrene-butadiene latex material, an anti-blocking agent and a solvent.

7. A process as defined by Claim 6 wherein the anti-blocking agent is an anionic co-emulsion of carnauba and paraffin waxes.

8. A process as defined by Claim 6 wherein the solvent is a blend of 1,1,1-trichloroethane and diethylene ether.

9. A process as defined by Claim 1 wherein the liquid reinforcing composition penetrates to a depth of from about 10 to about 20 percent of the paperboard thickness.

10. A process as defined by Claim 1 wherein the liquid reinforcing composition comprises a water-based acrylic material.

11. A process as defined by Claim 1 wherein the liquid reinforcing composition comprises a sodium silicate and water.

12. A process as defined by Claim 6 wherein the solvent is a blend of diethylene glycol monoethyl ether and ethylene glycol.

13. A reinforced paperboard made in accordance with a process as defined by Claim 1.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 91 30 8286

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X Y	GB-A-2 229 136 (NDP CORP) * page 4, line 34 - page 8, line 18; claims 36-43 *	1,3,9,13 4-7,10	D21H25/00 D21H25/02 D21H21/18
Y	FR-A-1 524 265 (ESSO CHIMIE) * the whole document *	4-7	
Y	US-A-4 910 066 (R.A. FOISIE) * abstract *	10	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			D21H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13 JANUARY 1992	SONGY Odile

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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